

VISIT...

LANZAROTE
Caliente.COM

Star Cactus (*Astrophytum asterias*)

Recovery Plan

September 2003

STAR CACTUS
(Astrophytum asterias)

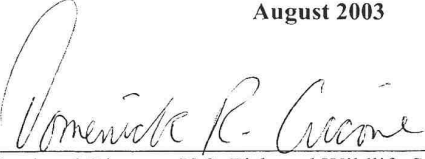
RECOVERY PLAN

Original Recovery Plan

Southwest Region
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

August 2003

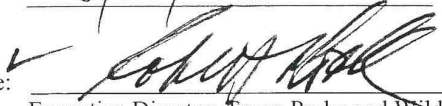
Approved:

 Acting
Regional Director, U.S. Fish and Wildlife Service

Date:

8/26/2003

Concurrence:

✓ 
Executive Director, Texas Parks and Wildlife Department

Date:

9.19.03

DISCLAIMER

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved as well as the need to address other priorities. Recovery plans do not necessarily represent the views or the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service **only** after they have been signed by the Regional Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 2003. Recovery Plan for Star Cactus (*Astrophytum asterias*).
U.S. DOI Fish and Wildlife Service, Albuquerque, New Mexico. i-vii + 38pp., A1-19, B-1-8.

Additional copies may be purchased from:
Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
1-301-492-6403 or 1-800-582-3421

The fee for the Plan varies depending on the number of pages of the Plan. Recovery Plans can be downloaded from the U.S. Fish and Wildlife Service website: <http://endangered.fws.gov>.

ACKNOWLEDGMENTS

The author wishes to express great appreciation to Ms. Angela Brooks (formerly of the U.S. Fish and Wildlife Service) for her original work on the draft recovery plan. Without her devotion to endangered species protection with emphasis on plant conservation in South Texas, this recovery plan would not be complete. Additionally, the author appreciates the review and editing work performed by Ms. Robyn Cobb (U.S. Fish and Wildlife Service), Ms. Sharon Becton (U.S. Fish and Wildlife Service), Ms. Mary Orms (U.S. Fish and Wildlife Service), and Ms. Tracy Scheffler (U.S. Fish and Wildlife Service), as well as Mr. Tom Shearer (U.S. Fish and Wildlife Service) and Ms. Meris Sims (U.S. Fish and Wildlife Service) for their mapping assistance, and thanks go to Ms. Jackie Poole and Ms. Dana Price of the Texas Parks and Wildlife Department for their involvement in the development of this recovery plan, as well as their continued support for protecting endangered, threatened, and rare plant species in Texas.

Recovery Plan prepared by Loretta Schanen Pressly, U.S. Fish and Wildlife Service, Corpus Christi, Texas.

EXECUTIVE SUMMARY

Current Status: Star cactus is listed as endangered. Currently, a small number of sites are known to support the species in varying numbers in Texas and Mexico. One population composed of two subpopulations is present on private land in Starr County, Texas; several populations exist in Tamaulipas, Mexico; and one population has been documented in Nuevo Leon, Mexico. Other populations exist in the United States and Mexico but remain undocumented due to difficulty in gaining access for surveys on private land and in targeting habitat for surveys. Until further documentation is obtained, it is difficult to accurately gauge the current status of the species. Therefore, information gathering (i.e., surveys and research) and the application of such information to management and conservation are the foci of the recovery strategy recommended for star cactus.

Habitat Requirements and Limiting Factors: The star cactus grows in the grasslands and thorn shrub of the Rio Grande. The species is found on gravelly clays or loams overlaying the Tertiary Catahoula and Frio formations in the United States and on soils of limestone origin overlaying Cenozoic to Mesozoic marine sediments in Tamaulipas, Mexico. Habitat destruction and modification, collection, and decreased population numbers are major threats to the star cactus.

Recovery Objective: The current recovery objective for the star cactus is to reclassify the species as threatened through the protection of natural and/or reintroduced populations in natural habitat and in refugia collections and seed bank reserves. Recovery activities integral to achieving threatened status include surveys for the species, research, outreach and education, enforcement of existing laws, partnerships with private and public landowners, and development of a conservation strategy for the star cactus between the United States and Mexico. Recovery actions in the Star Cactus Recovery Plan (Plan) will both ensure the species' survival and provide the information necessary to develop delisting criteria in the near future.

Recovery Criteria: Maintain or establish ten fully protected, self-sustaining (i.e., a minimum of 2,000 individuals) populations of star cactus in the United States or Mexico on Federal lands (e.g., National Wildlife Refuge lands), voluntary State lands (e.g., State parks), voluntary private lands, or a combination, within the geographical and historical areas known to support the species. Full protection is considered management of the populations on Federal or State lands as part of an approved management plan, or a formal stewardship agreement with private landowners. Management should include monitoring the species' numbers and distribution, habitat, and threats. In addition, a formal conservation agreement between the United States and Mexico should be developed for the star cactus through the Canada/Mexico/United States Trilateral Committee for Wildlife and Ecosystem Conservation and Management (Trilateral Agreement).

Major Actions Needed:

1. Protect and manage existing star cactus populations and habitat in the United States and Mexico.
2. Gather information for management and monitoring programs for star cactus.
3. Search for new populations of star cactus in the United States and Mexico.
4. Establish and maintain a botanical garden population of star cactus.
5. Establish new populations in natural habitat as necessary to meet reclassification criteria.
6. Develop and implement a formal conservation agreement for star cactus between the United States and Mexico through the Trilateral Agreement.
7. Develop a public education and awareness program for the species.
8. Evaluate progress toward recovery, management direction, and status of information needed for development of delisting criteria within five years (2008-2009).

These eight actions are prioritized and subdivided into specific sub-activities in section PART II - RECOVERY of the Plan.

Estimated Cost of Recovery (in 1,000s):

The estimated cost of recovery is given for five years, as synthesis of new information may require an evaluation of management direction at that time. Costs that may continue throughout the estimated time to downlisting (10 years), pending major changes to the Plan during the five-year evaluation, are given in footnotes to the table. The costs below are also given in the Implementation Schedule.

Year	Major Action 1	Major Action 2	Major Action 3	Major Action 4	Major Action 5	Major Action 6	Major Action 7	Major Action 8	Total Estimated Cost
1	15.0	82.0	6.0	4.0	5.0	—	2.0	0.0	114.0
2	10.0	77.0	6.0	4.0	5.0	—	2.0	0.0	104.0
3	10.0	67.0	6.0	4.0	5.0	—	2.0	0.0	94.0
4	10.0	26.0	6.0	0.0	5.0	—	0.0	0.0	47.0
5	10.0	26.0	6.0	0.0	5.0	—	0.0	0.0	47.0
Total	55.0¹	278.0²	30.0	12.0	25.0	—³	6.0	0.0⁴	406.0

¹ Costs of approximately \$10,000/year may continue throughout the estimated ten years to reclassification for activities such as development of stewardship agreements for private landowners and law enforcement. ² Costs of approximately \$8,000/year may continue throughout the estimated ten years to reclassification for development of management/monitoring programs. ³ Costs will be developed when interested parties have been identified; costs could include meeting/travel logistics. ⁴ Major Action 7 may incur costs throughout the estimated ten years to reclassification if significant management adjustments need to be made to the Plan in the future. Costs could include convening a Recovery Team to develop delisting criteria based on new information and revising the existing Plan.

Date of Recovery: Reclassification to threatened status is estimated at ten years. This is based on the time it will take to survey existing habitat for unidentified populations, accomplish priority research needs, establish a botanical garden population and new wild populations, and implement management plans and stewardship agreements to protect known populations. Actions taken to reach threatened status will help secure the species while also providing information in critical areas such as population biology, habitat/ecological requirements, species' responses to habitat modifications, and quantification of threats. This information will set the stage for defining recovery and determining the degree of effort needed to reach recovered status. The estimated time to delisting is therefore contingent upon results obtained during the downlisting recovery period. The Plan will be reevaluated in five years (2008-2009) to assess progress on survey efforts, reintroduction, and research; management should be adapted as needed, including revision of the Plan.

TABLE OF CONTENTS

DISCLAIMER	i
ACKNOWLEDGMENTS	ii
EXECUTIVE SUMMARY	iii
TABLE OF CONTENTS	vi
PART I - BACKGROUND	
Status	1
Taxonomy	1
Morphology	2
Habitat Characteristics	3
Population Biology	5
Distribution and Abundance	6
Impacts and Threats	7
Conservation Measures and Research	9
PART II - RECOVERY PROGRAM	
Recovery Strategy	11
Objective and Criteria	11
Step-down Outline of Recovery Actions	15
Narrative Outline of Recovery Actions	17
Reduction or Alleviation of Threats to the Star Cactus Through Implementation of Recovery Actions	28
Implementation Schedule	30
PART III - LITERATURE CITED	36

FIGURES

Figure 1. Counties of currently known and potential star cactus locations in Texas, United States	2
Figure 2. Star cactus (<i>Astrophytum asterias</i>)	3
Figure 3. Comparison of morphological characteristics between star cactus and peyote	9

PART IV - Appendices

Appendix A - Comments Received on the Draft Recovery Plan during Stakeholder and Public/Peer Review in 2002	A-1
Appendix B - Responses to Comments	B-1

I. BACKGROUND

STATUS

Star cactus, *Astrophytum asterias* (Zuccarini) Lemaire, was listed as an endangered species on October 18, 1993, under authority of the Endangered Species Act (ESA) of 1973, as amended (U.S. Fish and Wildlife Service 1993). Critical habitat was not designated. Star cactus was listed as endangered by the State of Texas on January 30, 1997 (Texas Parks and Wildlife Executive Order No. 97-002). The star cactus has a recovery priority of 2; this indicates that the species faces a high degree of threat yet has high recovery potential.

The star cactus is known from one population subdivided into two smaller populations in Starr County, Texas (Figure 1), and several populations in Tamaulipas, Mexico. Other Tamaulipan populations exist, and re-verification surveys are ongoing (Jose Guadalupe Martinez Avalos, Universidad Autónoma de Tamaulipas, *in litt.* 2002). Star cactus has been reported in several areas in the State of Nuevo Leon in Mexico (Correll & Johnston 1979), and one population is still known to occur in Nuevo Leon (Jose Guadalupe Martinez Avalos, Universidad Autónoma de Tamaulipas, *in litt.* 2002). Additional populations have been reported at other locations in Texas and Mexico, and probably still exist; however, surveys and documentation can be difficult due to lack of exact locality information and/or access to private land.

The species can be found in semi-arid grassland and open thorn shrub habitats. Star cactus normally occurs on gravelly, calcareous loam and clay soils. The species is threatened by habitat destruction and modification through conversion of native vegetation to rangeland and row crop, possible competition with exotic grasses introduced for cattle forage, and urban development; collection of wild plants for the cactus trade; and genetic vulnerability due to low population numbers. Through the potential growth of the human population in relation to the North American Free Trade Agreement, additional habitat may be lost due to increased urbanization.

TAXONOMY

The star cactus was originally collected in Tamaulipas, Mexico, by Baron von Karwinsky in 1843, and named *Echinocactus asterias* by Joseph Zuccarini in 1845. It is possible that both Karwinsky and Zuccarini collected star cactus from Tamaulipas in 1843 (Benson 1982). Charles A. Lemaire described *Astrophytum prismaticum* in 1868 and included *Echinocactus asterias* in the new genus *Astrophytum*. Star cactus then became *Astrophytum asterias* (Zuccarini) Lemaire. Various taxonomic treatments have placed star cactus in either the genus *Astrophytum* or *Echinocactus*. Placement of star cactus in the genus *Astrophytum* was chosen by the U.S. Fish and Wildlife Service (Service) because of the prevalent use of this name in the horticultural literature.

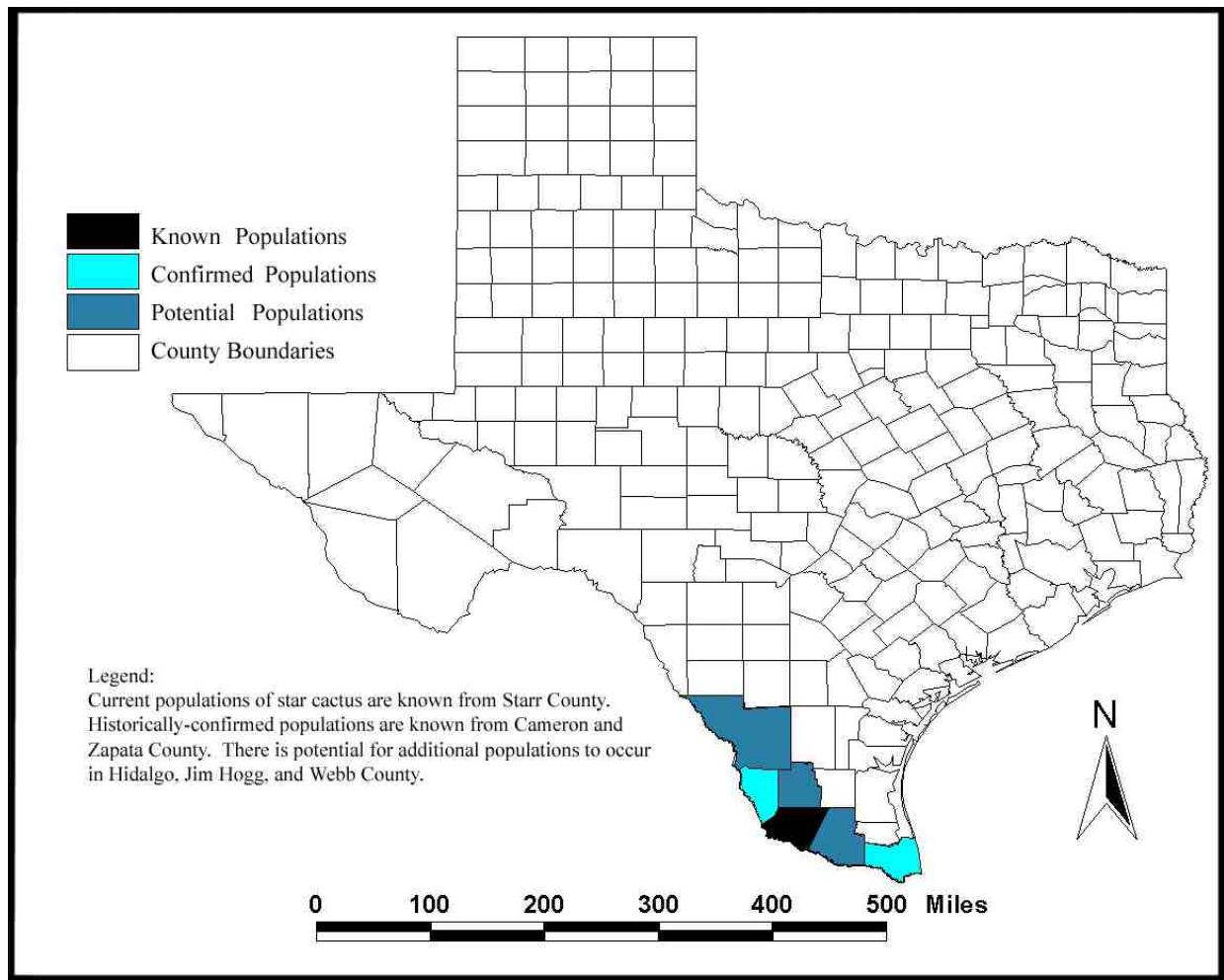


Figure 1. Counties of occurrence of currently known and potential star cactus populations in Texas, United States.

MORPHOLOGY

The star cactus is a small, spineless, disk or dome-shaped member of the Family Cactaceae (Cactus Family). It is 2–15 centimeters (1–6 inches) across, and up to 7 centimeters (3 inches) tall. Star cactus is dull green-to-brown in color, often speckled with a covering of tiny white scales. The body is divided into eight, vaguely triangular sections. Each triangular section has a central line of circular

indentations (areoles) filled with whitish, wooly hairs. During periods of adequate moisture, star cactus is usually a dull green color; however, during droughts, the cactus becomes brownish and loses fullness so that it becomes flush with the ground and almost perfectly camouflaged (Figure 2). Flowers are yellow with orange centers, and up to 15 centimeters (6 inches) in diameter. The fruits of star cactus are green to grayish-red,

somewhat obscured by white wooly hairs, about 1.25 centimeters (0.5 inches) long, oval, and fleshy when mature. The seeds are glossy, dark brown with an enlargement of a chamber of the seed coat forming a flaring collar that encircles the hilum (Damude and Poole 1990, Benson 1982).

HABITAT CHARACTERISTICS

Star cactus occurs at low elevations in sparse, open thorn shrub and grasslands in a warm-temperate, subtropical steppe climate in the United States and in dry, hot thorn shrub in Mexico. The species is found within the Tamaulipan biotic province (Blair 1950) which includes South Texas and Mexico. This semi-arid biotic province is characterized by scattered mesquite and grasses (mesquital-zacatal) on sandy soils and thorn brush species (mesquital-chaparral) on heavier soils. The introduction of cattle and the suppression of fire have reduced the grassland component of this province while increasing the woody species component. Star cactus individuals are occasionally found in the open, but typically occur within the partial shade of other plants or rocks.

Star cactus can be found growing on gravelly clays and loams overlaying the Tertiary Catahoula and Frio formations in the United States, and on soils of limestone origin overlaying Cenozoic to Mesozoic marine sediments in Tamaulipas (Sanchez-Mejorada *et al.* 1986, Damude and Poole 1990). The site of the known United States population is mapped as part of the Catarina soil series; however, Damude and Poole (1990) note that observers at the site characterized the soils as being gravelly loams more closely resembling the Jimenez-Quemado association (Thompson *et al.* 1972). A rediscovered historical site,



Figure 2. Star Cactus (*Astrophytum asterias*). Photo above courtesy of Chris Best, U.S. Fish and Wildlife Service. Photo below courtesy of Loretta Pressly, U.S. Fish and Wildlife Service. (Star cactus specimen is near the middle of the photo.)



now likely extirpated by colonia development, located in the hills northeast of Roma in Starr County, is mapped as Jimenez-Quemado soils (Thompson *et al.* 1972). These shallow, gravelly soils are underlain by caliche and support a barreta (*Helietta parvifolia*) community. Wu & Smeins (1999) developed regional-scale and site-scale models to predict probabilities of occurrence of rare plant populations and/or habitat in a 13-county study

area that included Cameron, Hidalgo, Starr, Webb, and Zapata. This report suggests that the star cactus may have a larger range well away from the Rio Grande. Thus, the range of the star cactus is likely to extend beyond that described as being located on Catarina soils. There was one account of star cactus in the southern portion of Jim Hogg County, although it is believed that this population has been extirpated (Glenn A. Spraker, cactus enthusiast, in litt. 1997).

The documented United States population consists of two sub-populations with approximately 2,000 individuals located within a twenty-acre area. One of the sub-populations occurs within an open, gravelly, flat area dominated by a sparse cover of mesquite (*Prosopis glandulosa*) and grasses (*Pennisetum ciliare*, *Bouteloua trifida*, *Aristida* sp.). The other sub-population is found nearby on rocky hillsides with a heavier cover of mesquite and blackbrush (*Acacia rigidula*). In both areas native vegetation has been significantly altered by range management practices of clearing and overgrazing. The original vegetation of the site was more likely an open desert or subtropical grassland. Several other species of cacti, both common and somewhat rare, are found at this site. Other species found at the site in association with star cactus include: goldenweed (*Isocoma drummondii*), Lindheimer prickly-pear (*Opuntia lindheimeri*), tasajillo (*Opuntia leptocaulis*), amargosa (*Castela texana*), allthorn (*Koberlinia spinosa*), twisted-rib cactus (*Echinocactus setispinus* var. *hamatus*), horsecriple (*Echinocactus texensis*), lotebush (*Ziziphus obtusifolia*), saladillo (*Varilla texana*), coma (*Bumelia celastrina*), popote (*Ephedra antisiphilitica*), nipple

cactus (*Mammillaria heyderi*), Runyon's coryphantha (*Coryphantha macromeris* var. *runyonii*), glory of Texas (*Thelocactus bicolor*), shoregrass (*Monanthochloe littoralis*), Fitch's hedgehog cactus (*Echinocereus reichenbachii* var. *fitchii*), sacasil (*Wilcoxia poselgeri*) and coyotillo (*Karwinskia humboldtiana*) (Correll and Johnston 1979, Damude and Poole 1990).

In Tamaulipas, star cactus occurs in several sites in Tamaulipan thorn shrub (also classified as Bosque Espinoso (Rzedowski 1978)), in sparsely vegetated, flat rocky soils of limestone origin at elevations below 200 meters (Sanchez-Mejorada et al. 1986). Associated plants include: lechuguilla (*Agave lechuguilla*), *Acacia* sp., *Prosopis glandulosa*, *Mammillaria heyderi*, *Yucca elephantipes*, cuajote amarillo (*Bursera fagaroides*), palo verde (*Cercidium macrum*), *Ariocarpus trigonus*, *Thelocactus bicolor* var. *schwarzii*, *Echinocactus texensis*, *Ancistrocactus megarhizus*, *Agave striata*, *Argemone platyceras*, *Hechtia* sp., creosotebush or gobernadora (*Larrea tridentata*), *Mammillaria meiacantha*, abrojo (*Opuntia imbricata*), *Mammillaria sphaerica*, *Echinocactus setispinus*, and ballmoss (*Tillandsia recurvata*) (Sanchez-Mejorada et al. 1986; Mason and Mason 1987; Charles Glass, Cactus and Succulent Society of America, in litt. 1994; Heinz Hoock, Cactus and Succulent Society of America, in litt. 1994). Diversity of vegetation varies at the Tamaulipan sites; tasajillo, (*Opuntia leptocaulis*), is reported as the dominant plant species at most of the sites (Jose Guadalupe Martinez Avalos, Universidad Autónoma de Tamaulipas, in litt. 2002). One Tamaulipan site has few individuals remaining due to collection from the site (Sanchez-Mejorada et al. 1986).

POPULATION BIOLOGY

Star cactus has been observed flowering in the wild from March through May, with fruiting occurring from April through June; it is possible for flowering to occur after adequate rainfall in summer months. Cultivated specimens reportedly flower throughout the summer (Damude and Poole 1990). Sanchez-Mejorada *et al.* (1986) reports flowering during the summer months. Clover (1932) reports star cactus as flowering in April, with the flower only opening slightly the first bloom day and closing that evening. The following morning the flower opens fully and remains open until early evening. The flower remains fresh, yet almost closed, and withers by the end of the following day. It is not clear whether this observation of flowering was noted from the wild or from a cultivated specimen. Star cactus is likely insect pollinated, but specific pollinators have not been observed.

While star cactus has been reported to reproduce strictly by sexual out-crossing and seed production (Sanchez-Mejorada *et al.* 1986), individuals have been observed with the original, larger plant dead and shrunken, yet with juveniles present and growing up from the top of the desiccated remains of the mature plant. It is possible that these small cacti were the result of seed germination and establishment on the surface of the dead individual. Investigation into possible vegetative reproductive ability using cultivated material is warranted. Genetic baseline information may provide information whether individuals came from the same mother plant, and/or different pollen donors. Evidence of ongoing reproduction has been observed at both populations. Damude and Poole (1990) note that approximately twenty

five percent of the estimated 2,000 individuals were juveniles. Sanchez-Mejorada *et al.* (1986) reported observation of several seedlings within the 100 noted individuals at the Tamaulipas site. Actual age structure determination in the wild is difficult; therefore, it is not certain whether the populations are reproductively stable or fluctuating.

Seed dispersal mechanisms in the wild are virtually unknown. Mature fruits appear to disintegrate while still attached to the plant and leave a small cluster of seed on top of the plant. Wind and rain may carry the seeds away to establishment sites. Small rodents may also store the seeds at cache sites. Additionally, ants may play a role in seed dispersal. Ants have been observed by Service personnel in several fruits during field visits. They may not directly disperse the seed, but eating the funiculus may aid in seed dispersal. Dispersal information is necessary to understand the historic and current distribution of star cactus, the significance of habitat modifications that may alter dispersal patterns, and for appropriate distribution of reintroduced populations.

Star cactus is easy to cultivate from seed if given an appropriate sandy, slightly alkaline soil medium, containing a low amount of organic matter that allows the plants to better resist fungal attacks of the root system (Steven Brack, Mesa Gardens, *in litt.* 1992). San Antonio Botanical Garden, a Center for Plant Conservation member garden, has also reported successful germination of seed in a sandy medium (Dianne Simpson, San Antonio Botanical Gardens, *in litt.* 1994).

DISTRIBUTION AND ABUNDANCE*Present*

Star cactus is currently known from one population (2 sub-populations) comprised of 2,000 individuals in Starr County, Texas, and several populations in Tamaulipas and Nuevo Leon, Mexico. Steven Brack (Mesa Gardens, *in litt.* 1992) reported knowledge, but not site verifications, of two populations in Tamaulipas. Correll and Johnston (1979) indicate the possibility of additional populations in Tamaulipas and Nuevo Leon. One of the populations reported by Brack appears to be the same population documented in the Sanchez-Mejorada *et al.* report of 1986. In Mexico, the species appears to be limited in distribution to areas unsuitable for cultivation, as most of the available habitat for the species in Mexico has been converted to corn fields or orange groves (Sanchez-Mejorada *et al.* 1986). Cameron and Hidalgo Counties in Texas have also undergone a massive conversion of available native habitat to agriculture.

Historic

The historical range of star cactus included Hidalgo, Starr, Zapata, and possibly Cameron Counties in South Texas and the States of Nuevo Leon and Tamaulipas in Mexico. The Nuevo Leon site near Linares was probably extirpated by collectors; the same collection threat may be reducing other populations (Sanchez-Mejorada *et al.* 1986).

Octavio Solis collected star cactus in 1919 from Barretillas, Nuevo Leon, and Ciudad Guerrero, Tamaulipas (Britton and Rose 1922). Elzada Clover (1932) documented the collection of star cactus by Romeo Posselt near Ciudad Victoria, Tamaulipas, from heavy soils of limestone origin. Posselt noted that the species was generally found growing in

clusters of five to twenty plants in grassy areas and under small, sparse shrubs. Interestingly, Posselt also noted that star cactus was never found growing near other succulents, which is not the case at the Texas site. Damude and Poole (1990) note a historical location of star cactus at Presa de las Adjuntas, Tamaulipas.

The first documentation of the species occurrence in the United States is taken from receipts of a shipment from Flossie Garrison in January 1932, of cacti that were collected in the Rio Grande Valley of Texas (Clover 1932). This specimen was collected by M.A. Clover from a ranch north of Rio Grande City in Starr County, Texas. Plants were found growing on a south slope in sandy loam soils. Damude and Poole (1990) note the ambiguity of this site location; however, Benson (1969) indicates that this location may have also been the collection site for a specimen from A.D. Wood and F. L. Curtis.

Benson (1969) documents a collection of star cactus northeast of Roma, Starr County, Texas, by A.D. Wood on September 10, 1967. These baretta-dominated gravelly hills are rapidly undergoing urban and colonia development despite the lack of infrastructure such as utilities. In 1960, W. H. Earle found star cactus at a location west of Brownsville, Cameron County, Texas (Benson 1969). This site has not been relocated and is likely extirpated due to conversion of native habitat to agricultural fields. Weniger (1984) lists Hidalgo County, Texas, as part of the range of star cactus, but does not give an exact location or indicate a collected specimen.

IMPACTS AND THREATS (REASONS FOR LISTING)

The Service (1993) described major threats to the star cactus which, when combined, justified listing the species as endangered: (1) Destruction or modification of range through agricultural practices, highway construction, pesticide or herbicide use, invasive exotic grasses, suppression of fire cycles in the habitat in which it occurs, excessive grazing, and in Mexico, alteration of natural vegetation to cultivation for cash crops; (2)

Overutilization due to collection, as star cactus is highly prized by cactus enthusiasts for its rarity and unusual appearance; (3) Disease or predation, which although not evidenced at the time of listing, may be having deleterious effects, as herbivory by rodents has been reported recently in Texas; (4) Inadequate regulatory protection to limit plant collection; (5) Reduction of genetic variability (and viability) through diminution of population size through loss and/or habitat modification, with resulting increase in inbreeding and decrease in heterozygosity.

Habitat Loss

Habitat destruction and modification for range management are significant threats to star cactus. Methods of habitat conversion for agriculture and livestock grazing include root-plowing and similar mechanical or chemical brush clearing techniques, followed by (in the case of livestock grazing) the introduction of exotic, aggressive invasive grasses such as buffelgrass for cattle forage. These activities may directly or indirectly affect star cactus individuals and populations, but the mechanisms and degree to which such management may impact the species is not well understood. Little is known regarding the

effects of livestock grazing or trampling on star cactus or its associated community.

However, by comparing grazed portions of the known star cactus site in the United States with areas that have not been grazed, it is evident that the original native habitat has been significantly altered due to severe grazing and pasture improvements such as brush clearing and root plowing. A site in Mexico is reportedly grazed by both cattle and goats (Sanchez-Mejorada *et al.* 1986). Additionally, the suppression of natural fire cycles may have significantly altered or destroyed available habitat for the species throughout its range (Damude and Poole 1990).

The known star cactus site in the United States has been bisected by the construction of a paved road. The potential for future road improvements and current right-of-way management practices using pesticides or herbicides may pose a threat to this population or others that have not yet been identified.

Most of the available habitat for star cactus in Mexico is now under cultivation. Historic star cactus populations in Hidalgo and Cameron Counties have likely been extirpated through conversion of native habitat to agricultural fields. While much of the land suitable for agriculture has already been cleared, the remaining remnant of native habitat is increasingly threatened by urban development due to the rapid population increase along the Rio Grande. The species is presently restricted to rockier sites less suitable for agriculture; however, even these sites are threatened by overgrazing, primarily by cattle and goats (Sanchez-Mejorada *et al.* 1986).

Collection

Another major threat to star cactus is collection of plants from the wild. This cactus

is highly prized by cacti enthusiasts and has been in cultivation since the 1930s; however, plants collected from the wild are valued for their extreme rarity (U.S. Fish and Wildlife Service 1993). Clover (1932) noted that wild star cactus (possibly smuggled from Mexico) were in commerce at that time. Two dozen individuals purchased for the University of Michigan Botanical Garden collection at a flower market in Ann Arbor, Michigan, were obtained through a wholesaler in Detroit who had procured them from a dealer in Austin, Texas (Clover 1932). A 1991 survey of the cactus trade in Texas included 400 field-dug specimens at a Texas nursery (Poole and Westlund 1991). It was presumed that these specimens were collected from Mexico; however, it is possible that the plants were collected from an undocumented site in the United States.

Star cactus may be inadvertently removed and destroyed during the harvesting of peyote (*Lophophora williamsii*), a plant used in some Native American cultures for religious ceremonies. Star cactus and peyote have been found to occur on similar soil types, and when the two plants grow beside each other, the star cactus is sometimes mistakenly collected and discarded. Peyote is very similar morphologically to star cactus (Figure 3), although the body of the star cactus is divided into eight distinct triangular sections, each having a central line of circular indentations (areoles) filled with whitish, wooly hairs, whereas peyote does not have the distinct triangular sections and central line of areoles. Peyote sections may have an orbicular shape. The flower of peyote is pink in the middle and pale to white at the margins, whereas the star cactus flower is yellow.



Figure 3. Comparison of morphological characteristics between star cactus (photo above) and peyote (photo below). Star cactus (*Astrophytum asterias*) (Zuccarini) Lemaire photo courtesy of Charlie McDonald, USDA Forest Service. Note the presence of distinct narrow ridges separating the 8 ribs. Flower perianth 38-50 mm in diameter, yellow. Peyote (*Lophophora Williamsii*) Lemaire photo courtesy of James H. Everitt & D. Lynn Drawe, *Trees, Shrubs, & Cacti of South Texas*. Note the absence of distinct narrow ridges separating ribs. Flower perianth 12-25 mm in diameter, pale to nearly white.



The star cactus in Nuevo Leon is believed extirpated by collection. Sanchez-Mejorada, *et al.* (1986) also note that the Tamaulipan population had historically contained many large individuals up to 15 centimeters (6 inches) in diameter in 1978, but the site did not have any individuals larger than 7 centimeters (3 inches) when surveyed in 1985. There are indications that collection is ongoing at the Tamaulipan site and that local children are aware of foreigners' interest in star cactus and willingness to pay money for plants (Charles Glass, Cactus and Succulent Society of America, *in litt.* 1994).

Star cactus is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (50 CFR 23.23), which protects the species from international trade. Although Mexico has laws prohibiting export of native cacti, both Mexican import/export laws and CITES protections are difficult to enforce along a heavily trafficked border area such as Texas and Mexico (U.S. Fish and Wildlife Service 1993). Therefore, collection of wild plants will remain a primary threat to star cactus until education regarding conservation of plants replaces the present high value placed on plants collected from the wild. Listing the star cactus as endangered under the ESA also provides regulatory protection for the species (see next section, Conservation Measures and Research).

Disease or Predation

Drought has been ongoing in this area for an extended period (NOAA 2002), possibly resulting in lowered seed production and seedling recruitment. During a survey in 2001 by The Nature Conservancy (TNC), Texas Parks and Wildlife Department (TPWD), and

Service personnel, indication of predation on the plants by either small rodents or rabbits was evident. Some plants were only scarred by herbivores, but in some cases whole plants were consumed down to the root structure. This species of cactus is not known to regrow after significant levels of decimation.

Reduction of Genetic Variability

At the time of listing, the one site known to have the star cactus present contained fewer than 2,100 plants. Genetic variability and viability decrease with reduced numbers of plants across the range (Ledig 1986). This, along with the pressures of other natural and anthropogenically-induced threats, increases the possibility of extinction of the species in the wild.

CONSERVATION MEASURES AND RESEARCH

There are several regulatory tools that aid in the conservation of the star cactus, including:

Taking and Trade Prohibitions

In addition to the above-mentioned CITES protections regarding international trade, the ESA prohibits the malicious damage, destruction, or removal and reduction to possession of listed plants on areas under Federal jurisdiction. For areas not under Federal jurisdiction (e.g. private or State-owned lands), the ESA prohibits removing, cutting, digging up, damaging or destroying listed plants in knowing violation of any State law, including the violation of a State criminal trespass law. The ESA prohibits a person subject to the jurisdiction of the United States from selling, offering for sale, importing, exporting, or transporting in interstate or foreign commerce any listed plant species in the course of a commercial activity. The

Lacey Act prohibits the same activities if the species is listed under any State law that provides for the conservation of species threatened with extinction, or is listed on an appendix to CITES. Under certain circumstances, the ESA also provides for the issuance of permits to carry out otherwise prohibited activities involving listed species. Star cactus is listed as a State endangered species under the Texas Parks and Wildlife Department Code for Wildlife and Plant Conservation, Chapter 88.004.

ESA Section 7 Requirements

Section 7 of the ESA requires that all Federal agencies consult with the Service to ensure that actions authorized, funded or carried out by such agencies do not jeopardize the continued existence of any listed threatened or endangered species. It is the responsibility of the Federal action agency to determine if the proposed action may affect a listed species. Informal consultations with the Service are often undertaken by Federal action agencies to assist with determination of a project's potential impacts. If a "may affect" determination is made, the Federal action agency shall initiate the formal section 7 consultation process. During informal consultation, the Service may be able to assist the action agency in alternatives that eliminate the potential "may affect" action.

Other conservation measures and research efforts for the star cactus include:

The Wildlife Diversity Program of TPWD has conducted surveys for this species in Texas and visited several sites in Mexico. At present, star cactus is included as a search species in Mexico and ongoing surveys are performed by State (TPWD) and Federal

(United States & Mexico) biologists. One population of star cactus in Mexico is protected under a conservation agreement, and botanists at the Universidad Autonoma de Tamaulipas have performed research on size, distribution, related plant species, and pollination of the star cactus in Linares and San Carlos, Tamaulipas, Mexico (Jose Guadalupe Martinez Avalos, Universidad Autónoma de Tamaulipas, *in litt.* 2002). Efforts to locate additional populations of star cactus are ongoing by private researchers under university programs, contracts with ESA Section 6 funding, and other non-governmental agencies such as the Nature Conservancy of Texas.

The Star Cactus Recovery Plan (Plan) will function as an important conservation tool by structuring and prioritizing actions that will contribute to the species' survival and long-term conservation.

II. RECOVERY PROGRAM

RECOVERY STRATEGY

The recovery strategy for star cactus is based on the following general information:

- 1) Detailed information regarding the true status of star cactus abundance and distribution, aspects of life history and ecology such as identification of pollinators, seed dispersal mechanisms, and response to habitat modifications and other threats, and quantification of threats, including illegal collection, from which management recommendations can be made is currently inadequate.
- 2) Information that is currently available for conservation efforts includes star cactus historic range, location of documented populations, basic habitat requirements, some aspects of basic population biology, cultivation success, land ownership and management patterns, and minimum viable population size estimates.
- 3) According to current documentation, the species is apparently rare across its historic range.

Therefore, the recovery strategy for the star cactus is to identify, prioritize, and fill information gaps that currently hinder our ability to conserve the species and to apply such information to management decisions, conservation agreements, and educational programs, for the purpose of alleviating threats to star cactus and recovering the species within its historic range.

OBJECTIVE AND RECOVERY CRITERIA

The primary objective of this recovery plan is to ensure survival and promote recovery of star cactus in its natural habitat such that the species can be reclassified to threatened status. Focal points of the recovery program include the need to survey extensively for additional populations, using reintroduction as a secondary method for achieving the recovery criteria, and the need to partner with private landowners to promote conservation of the species on private lands in the United States and Mexico. The recovery actions recommended below will achieve the objective and recovery criteria set forth in the Plan. In addition, completion of recovery actions will enable development of a full recovery strategy and delisting criteria within five to ten years.

The criteria for reclassification to threatened are:

(1) Maintain or establish ten geographically distinct, fully protected, self-sustaining populations of star cactus in the United States or Mexico, each with a minimum of 2,000 individuals and an age class structure reflecting that plants are reproducing and becoming naturally established within the population. These populations can be composed of smaller sub-populations so that the units function as one large meta-population if habitat availability is limited and fragmented. The number of plants, numbers of reproductive individuals, size and age class structure must be verified through monitoring.

Reintroduction, if necessary, can occur on Federal land, voluntary State land, or private land that has been entered into a stewardship agreement for the star cactus. The basis for ten populations to achieve downlisting takes into account the number of known historical and extant populations, the amount of range yet to be surveyed, and reflects adequate population repetition such that extinction is deemed unlikely. Recent reports of additional populations within the known range of the star cactus are acknowledged as potentially contributing toward downlisting, although re-verification is needed. Extensive survey efforts for the star cactus will be necessary to achieve downlisting and eventual delisting. Long term monitoring data is not available for analysis of natural population fluctuations (i.e., rate of demographic change). However, populations counting towards the downlisting goal (i.e., self-sustaining) should not exceed standard fluctuations and should exhibit stable or positive trends such that remission to endangered status is not deemed likely once the species is reclassified.

The recommendation for minimum viable population size for star cactus of 2,000 individuals is based on the concept that a minimum viable population (MVP) should maintain enough individuals to ensure that there is a 95 percent probability that the population will remain viable over a period of one-hundred years (Mace and Lande 1991). MVP size for the star cactus should take into account the life characteristics of the plant, the extent of appropriate habitat, and threats to the species. Characteristics of the plant that should be examined include the life habit, breeding system, growth form, fecundity, ramet production (if any), survivorship, seed duration, environmental variation, and

successional status (Pavlik 1996). According to these characterization standards and available information on star cactus, MVP for the star cactus requires a population size of approximately 2,000 individuals. This is based on the perennial lifestyle, possible out-crossing ability, growth form, low fecundity, survivorship, reproduction patterns, seed duration and age when the plant matures, as well as seasonal patterns in relation to rainfall.

Full protection is considered management of the populations on Federal or State lands as part of an approved management plan (e.g., National Wildlife Refuge Comprehensive Conservation Plan), or a formal stewardship agreement with private landowners that includes management and monitoring of the population, habitat, and threats. Management should include measures to lessen or alleviate relevant threats (e.g., habitat loss or collection pressure) to star cactus and to measure the species' numbers, habitat quality, and threats.

Surveys for existing, unidentified star cactus populations on Federal, State, and private lands are essential in the United States and Mexico. Information gained in survey efforts will have a significant bearing on the full recovery strategy for this species (i.e., in relation to star cactus abundance and distribution necessary and available for recovery). In addition, the number of populations found will likely determine the intensity of reintroduction efforts required for delisting. The importance of surveying as a component of the recovery program underscores the benefit of continued and increased cooperation between all partners, including private landowners.

The type of soils (Catarina & Jimenez-Quemado) in Starr County, Texas, where most of the populations of star cactus have been located (historic and current) consists of approximately 83,000 acres (33,994 hectares). Additional populations found on Federal, State, or private land during surveys that fit the definition of a minimum viable population and can be protected with adequate management and monitoring programs, will count towards reclassification. If however, such populations are not found, reintroduction within the historical and geographical range will be necessary to reach reclassification targets.

Reintroduction can take place on Federal, State, or private lands in Texas or Mexico. There are currently at least two distinct tracts of National Wildlife Refuge (NWR) land in Texas that have the type of soil and habitat necessary for star cactus reintroduction (Chris Best, U.S. Fish and Wildlife Service, personal communication, 2003). Other lands may be available for reintroduction, such as State park lands, or private lands whose owners are willing to enter into stewardship agreements to manage and protect star cactus. However, until these partnerships can be developed, NWR lands may offer the most immediate opportunity for reintroduction. To protect the species from smaller-scale catastrophic events (e.g., a localized fire as opposed to widespread drought), it is recommended that populations counting towards recovery be geographically distinct from one another. To protect the species from larger stochastic events, it is recommended that populations for recovery be distributed/established in both Texas and Mexico.

Without adequate information about the basic life history and ecology of the species, a

strategy for full recovery (i.e., delisting criteria) can not be developed. With this in mind, reintroduction sites, if necessary, should also be used for compatible research activities. Combining these activities will maximize the immediate survival and protection of the species while allowing for the information gathering that is critical to move the species toward recovery. The research actions listed in the step-down and narrative outlines will provide information that will be used to determine how many populations are needed for recovery, how the populations should be distributed, management options for alleviating threats, and other relevant components of recovery.

To resolve the detailed information needs for star cactus management and conservation as efficiently as possible, scientific workshops should be convened and a recovery team should be developed. Workshops should include binational collaboration from partners in Federal, State, and academic institutions, conservation organizations, consultants, landowners, and other experts as necessary. Genetic data analysis, reintroduction protocol, and research priorities are all topics integral to the development of recommendations for survival and long-term viability of the species that could be addressed through these forums.

(2) Develop and implement a formal conservation agreement for star cactus between the United States and Mexico. The range of the star cactus spans the border between the United States and Mexico, and the status of star cactus in each country is important for the overall conservation of the species. A binational conservation agreement for the species should be coordinated through the Trilateral Agreement, a Memorandum of

Understanding between Canada, Mexico, and the United States for transnational species' conservation. This coordination will provide (further) protective measures for the species and may be integral for range-wide recovery, as significant opportunities for recovery projects may exist outside of the United States.

The time estimated to accomplish these criteria is ten years. However, the Plan should be reevaluated in five years to assess progress on surveys, research, partnership building, and reintroduction projects. The overall management strategy for the species, including the Plan, should be revised, based on new information, if needed. Delisting criteria should be developed at this time or when the objectives of the Plan have been met.

STEP-DOWN OUTLINE OF RECOVERY ACTIONS

Completion of these actions will satisfy the downlisting criteria and achieve the recovery objective to reclassify the species as threatened. In addition, these actions will enable development of delisting criteria. Although several of the actions are immediately needed to ensure the species survival (i.e., Priority 1 tasks in the Implementation Schedule), it is recommended that a coordinated approach to recovery be taken such that surveys, research, partnership building and educational efforts occur simultaneously or as needed.

1. Protect star cactus populations in the United States and Mexico.
 - 1.1 Provide landowners with information on the identity, rarity, and significance of star cactus, and on threats to the species.
 - 1.2 Develop and implement star cactus stewardship agreements with voluntary landowners whose long- and short-term land-use goals are compatible with star cactus conservation needs.
 - 1.3 Enforce applicable laws and regulations.
2. Conduct studies to gather biological information about star cactus that is needed for management and recovery in the wild.
 - 2.1 Determine specific habitat requirements.
 - 2.1.1 Study soils and underlying geology.
 - 2.1.2 Determine community structure.
 - 2.1.3 Study ecology and dynamic processes of associated community.
 - 2.1.3.1 Study direct and indirect effects of land use practices on star cactus and its associated habitat.
 - 2.1.3.2 Study interactions with other species (beneficial and negative).
 - 2.1.3.3 Study the responses to periodic or cyclic processes such as flooding, fire, and freezing temperatures.
 - 2.2 Study population biology.
 - 2.2.1 Conduct a demographic analysis of the populations.

- 2.2.2 Characterize phenology.
- 2.2.3 Study pollination biology.
- 2.2.4 Study seed production and dispersal in the wild.
- 2.2.5 Study seedling recruitment.
- 2.2.6 Study population genetics to determine genetic diversity within and among populations.
- 2.3 Develop management/monitoring programs for existing and reintroduced populations.
- 3. Search for new populations.
- 4. Establish a botanical garden population and seed bank; capture baseline genetic data.
- 5. Establish new populations as necessary to meet downlisting criteria.
- 6. Develop and implement a formal conservation agreement for star cactus between the United States and Mexico.
- 7. Develop a public information and awareness program.
- 8. Evaluate progress toward recovery, management direction, and status of information needed to develop delisting criteria, within five years (2008-2009).

NARRATIVE OUTLINE OF RECOVERY ACTIONS

1. Protect star cactus populations in the United States and Mexico. The existing known population(s) and newly discovered populations of star cactus should be protected from anthropogenic threats such as collection and habitat destruction or degradation.

- 1.1 Provide landowners with information on the identity, rarity, and significance of star cactus, and on threats to the species. Landowner involvement is an important aspect of this Plan, as the only known United States' population exists on private land, and other populations may be identified through public outreach and survey efforts. The landowners at the known United States site have been aware of the presence of the star cactus on their property for a number of years. An outreach program will be established to educate landowners in the species' historic habitat on Federal and State endangered species programs, and on how such programs may be compatible with private landowner land use practices. The Service will work with the government of Mexico to provide educational information on the star cactus so that partnerships with landowners are developed in both countries. If you would like more information on the Service's projects or programs, or if you have information you wish to share concerning star cactus, please contact:

U.S. Fish and Wildlife Service, Corpus Christi Ecological Services, c/o
TAMUCC, 6300 Ocean Dr., Box 338, Corpus Christi, Texas 78412. Tel. (361)
994-9005.

- 1.2 Develop and implement star cactus stewardship agreements with voluntary landowners whose long and short term land-use goals are compatible with star cactus conservation needs. Landowner participation should be encouraged in establishing long-term protection to as many population sites as possible. Simply locating and documenting additional populations will not recover the species. Protection for known and newly discovered populations is necessary to ensure the survival and recovery of the species. A variety of stewardship agreements are available that can be customized to maintain the land use practices of the landowner, as well as promote conservation of the star cactus. Voluntary, agreements with conservation organizations such as the Nature Conservancy and/or a similar agency in Mexico should be established with private landowners. Long-term, binding agreements could include conservation easements or the sale or donation of land to a conservation organization. Programs that could include active habitat restoration or research could be funded through Partners for Wildlife (U.S. Fish and Wildlife Service) or private lands programs with Texas Parks and Wildlife Department. For information on any of these programs, contact:

U.S. Fish and Wildlife Service, Corpus Christi Ecological Services, c/o
TAMUCC, 6300 Ocean Dr., Box 338, Corpus Christi, Texas 78412. Tel. (361)

994-9005.

Texas Parks and Wildlife, Wildlife Diversity Program, 3000 IH 35 South, Suite 100, Austin, Texas 78704. Tel. (512) 912-7011.

Lisa Williams, The Nature Conservancy of Texas, South Texas Office, P.O. Box 6281, McAllen, Texas 78502-6281. Tel. (956) 580-4241.

- 1.3 Enforce applicable laws and regulations. Federal and State agencies should exercise full authority to assist landowners and land managers to protect populations. The legal responsibilities of landowners for conserving endangered plants occurring on their land are limited. However, if landowners receive Federal funds or authorization for a project on their land, the Federal action agency providing the funds or authorization must ensure that those activities do not jeopardize the continued existence of the species in the wild. Federal agencies must conduct formal section 7 consultations under the ESA if an action authorized, funded, or carried out by a Federal agency may adversely affect a threatened or endangered species. Informal consultations with the Service are often undertaken by Federal agencies to assist in determining a project's potential impact. It is a violation of the ESA for any person to maliciously damage or destroy an endangered plant in the course of a violation of a State criminal trespass law. Investigators must obtain permission from landowners prior to conducting studies on private land.

Federal or State trade permits will likely be sought for this species, as it has been commercially traded since the 1930s. The majority of trade in star cactus involves plants artificially propagated from seed; however, field collected plants from the wild were still being offered for sale as recently as 1990. Requests for copies of the regulations on listed plants and inquiries regarding prohibitions and permits for international trade may be addressed to:

Office of Management Authority, U.S. Fish and Wildlife Service, 4401 N. Fairfax Drive, Room 432, Arlington, Virginia 22203. Tel (703)358-2104, fax (703)358-2281.

Similar requests concerning interstate trade are to be addressed to the appropriate Regional Office of the U.S. Fish and Wildlife Service. For the States of Arizona, New Mexico, Oklahoma, and Texas, contact:

Division of Endangered Species/Permits, U.S. Fish and Wildlife Service, P.O. Box 1306, Albuquerque, New Mexico 87103. Tel. (505)248-6920. Fax (505)248-6788.

A State permit is required for collection of listed plants from private land for commercial purposes. A State permit is also required for research activity conducted on public land. Commercial collection of listed plants is not allowed on public land. Requests concerning Texas State scientific or trade permits are to be addressed to:

Permitting Office, Wildlife Division, Texas Parks and Wildlife, 4200 Smith School Road, Austin Texas 78744. Tel. (512)389-4491. Fax (512)389-4550.

Star cactus was included in Appendix II of CITES (50 CFR 23.23) on July 1, 1975, and transferred to Appendix I effective October 22, 1987 (52 FR 35743). Appendix I species are those in which both an import and export permit is usually required before international shipment occurs. The import or export can not be allowed if the purpose is primarily commercial. Plants that are certified as artificially propagated require only an export document under international shipment and commercial shipments may be allowed.

2. Conduct studies to gather biological information about star cactus that is needed for management and recovery in the wild. Information on ecology, life history, population biology, and pollination of star cactus in its native habitat is scarce. This lack of information limits efforts to develop effective management for the species. Most of the information available on star cactus relates to its ease of cultivation and growth in greenhouses. No studies have been carried out on the species in the wild. Studies conducted to gather basic biological information on the species should focus on factors that will enable a better understanding of its ecological requirements and provide insight into effective management for the species. Information obtained from the studies should be incorporated into management plans, as appropriate, to assist recovery of the species. Ultimately the information should be used to determine a comprehensive strategy to fully recover and delist the species. Recovery teams and workshops should be convened, as necessary, to further develop, prioritize, and coordinate research needs, and synthesize research results.

- 2.1 Determine specific habitat requirements. Only general information is known about the habitat requirements of star cactus. More detailed habitat information would aid in targeting potential habitat for surveys and in locating additional populations. This specific information would also enable the Service to identify appropriate areas on Federal lands (within the historic range of the species) for future reintroduction efforts.

- 2.1.1 Study soils and underlying geology. Only the most general information regarding soils and underlying geology is known for the populations of star cactus. A preliminary soils analysis for a sub-population of the United

States site, undertaken by the San Antonio Botanical Garden, provides information somewhat contradictory to observations of associated plants. This analysis indicated a lower salinity (325 ppm) than is typical in those areas where halophytic plants are usually found. This preliminary analysis also provided expected information, such as moderate alkalinity (8.1) and high calcium content (18,732 ppm). Other elements measured in the analysis were noted as follows (in ppm): nitrogen (5), phosphorous (71), magnesium (493), zinc (0.20), iron (2.91), manganese (3.06), copper (0.34), sodium (137), sulphur (560), and boron (1.43). A complete soils analysis from the sub-population site, both near individual plants and in the surrounding habitat, needs to be undertaken. This basic information may provide a partial explanation as to why star cactus has not established in other areas of apparently suitable, available habitat.

- 2.1.2 Determine community structure. Only general information regarding the community structure at the United States and Mexico sites is known. Specific, detailed, quantitative measurements have not been carried out. The characterization of the community structure should include associated species, calculations of dominance, density, frequency, fidelity, species diversity, age class structure, and spatial patterning of associated thorn shrub and star cactus.
- 2.1.3 Study ecology and dynamic processes of associated community. Little is known about the basic community ecology and dynamic processes that may be critical to the preservation of star cactus. Studies are needed to determine this species' response to seasonal and cyclical processes, differing land management practices and disturbances, periodic climatic factors such as flooding and freezing, drought, fire, and interactions with other species with which it occurs. Successful management and recovery of the species depends on an understanding of the species' appropriate habitat, the species' significance as a component within the community, and the potential importance of interactions with associated species.
 - 2.1.3.1 Study direct and indirect effects of land use practices on star cactus and its associated habitat. Although the habitat of the known populations of star cactus in Texas is presently grazed, little is known regarding the effects of trampling or browsing on the species. In addition to these potential direct effects, the extent to which grazing alters existing vegetation, nutrient cycling, or the edaphic (stability and water infiltration ability) basis of the system is not known. It is evident that the native vegetation in portions of the United States' site has been significantly altered due to past

grazing and pasture improvements such as brush clearing, root-plowing, and introduction of non-native grasses such as buffelgrass.

Although there is no indication that cattle consume star cactus, grazing on associated species may cause direct and indirect impacts to the species by trampling on individuals, alteration of vegetation composition and structure, changes in soil and water resource distribution as a result of long-term grazing in an arid environment, introduction of non-native species, disruption of nutrient cycling through damage to the thin microbiotic crust over the soil, and edaphic macrohabitat changes, such as soil compaction, decreased water infiltration ability, and the reduction of soil litter (Sanchez-Mejorada *et al.* 1986, Schlesinger *et al.* 1990, Fleischner 1994). The impacts of grazing on star cactus need careful assessment given the significant ecosystem changes that can result from grazing. However, since all known star cactus populations have been found on range sites, comparison of sites with a non-grazed population may not be possible. Small exclosure studies may provide some insight; however, the actual impact of grazing will likely be underestimated because the original, and far more intense, impact has already occurred (Fleischner 1994). Research in this area should be coordinated with Step-down Action 2.1.3.2 so that duplication does not occur.

Insecticides used for control of pests on nearby agricultural land may affect star cactus through direct mortality of pollinators. Use of such chemicals in the area where the cactus occurs should be investigated, including a review of label data and supporting literature to determine the likelihood of negative impacts.

Herbicide application to reduce shrub or brush habitat along roadway rights-of-way as well as agricultural management areas should also be examined to determine best-management practices to reduce effects to the star cactus, especially in areas that may become developed. Based on this information, appropriate actions to protect star cactus and its associated habitat can be taken.

2.1.3.2 Study interactions with other species (beneficial and negative).

Interaction studies between star cactus and associated species need to be conducted. Although plants are sometimes found in the open, most individuals are located within the protection and semi-shade

of open, scattered thorn shrub. Frequently, multiple cacti species are grouped beneath these shrubs at the United States site. Star cactus is also found within the shade of larger rocks or growing out in the open, surrounded and almost camouflaged, by rocks of varying sizes. The extent to which other plants may act as "nurse plants", providing shelter from predation, shading (with the resultant tempered microclimate), more favorable microclimate for seedling germination and establishment, higher nutrient levels or other favorable edaphic factors, warrants investigation (Barbour et al. 1979, Nabhan 1987). The degree of fidelity (dependence) of star cactus with other species is not known.

Star cactus is vulnerable to increased competition from invasive, non-native forage grasses such as buffelgrass. This grass is commonly introduced for cattle forage following range improvement practices such as root-plowing and brush removal. However, buffelgrass has invaded areas where it was not originally planted. Buffelgrass can displace native vegetation and possibly create changes in the surrounding habitat through allelopathic mechanisms that prevent re-establishment of other species (Nurdin & Fulbright 1990).

No specific predators or pests have been identified for star cactus; however, damaged individuals have occasionally been noted. Damude and Poole (1990) report that fungal infections and scale insects have proven to be problems for plants under cultivation in greenhouses.

2.1.3.3 Study the responses to periodic or cyclic processes such as flooding, fire, drought, and freezing temperatures. Nothing is known about the response of star cactus to events such as flooding, fire, or freezing temperatures. A portion of one sub-population at the United States site is within a low flat area that occasionally ponds water. Only a few plants have become established here. The role of star cactus in the ecosystem prior to significant alteration of the vegetation resulting from fire suppression, grazing, and possible shrub encroachment is unknown. Drought effects probably reduce seed production and seedling recruitment (e.g., there may be predation on the plants by either small rodents or rabbits during high drought years). In addition, although periodic freezing temperatures are estimated to occur seven years out of ten, the actual response of the species in the wild to these freezes is

unknown (Thompson *et al.* 1972). Plants growing in a cold greenhouse have not shown signs of stress from temperatures as low as 10°F (Steven Brack, Mesa Gardens, *in litt.* 1992).

- 2.2 Study population biology. Little is known about the status of star cactus in terms of population stability or demographic trends, phenology (relationship of climate and seasonality to plant life cycle stages), reproductive biology of the species in the wild, and the genetic viability and variation between populations. This information is critical to establishing effective management for the maintenance and establishment of populations.
- 2.2.1 Conduct a demographic analysis of the populations. Little is known of the demographics of the star cactus population. The documented United States population is a metapopulation comprised of two sub-populations in differing abiotic and biotic conditions. One sub-population occurs on gravelly slopes within a thorn shrub community. The other sub-population occurs in a rocky flat area with scattered shrubs and grasses. This site has approximately 2,000 individuals, 25 percent of which are juvenile plants (Damude and Poole 1990). The Tamaulipas site has been reduced to small individuals through collection (Sanchez-Mejorada *et al.* 1986). Brack (Mesa Gardens, *in litt.* 1992) had specimens under cultivation that are 20 years old; however, age determination for wild individuals has not been undertaken. Studies on natural population variation, age class distribution, survivorship, resource allocation patterns, and the spatial relationships of star cactus to its associated species are necessary to evaluate critical life stages and vulnerability to threats (Harper 1977, Pavlik 1987).
- 2.2.2 Characterize phenology. The relationship of climate and seasonality of the star cactus' life cycle in the wild needs investigation. Cultivated specimens apparently flower throughout the summer months (June - September), while in the wild star cactus in the United States flowers March through May and during summer at the Mexico site (Brack, Mesa Gardens, *in litt.* 1992; Damude and Poole 1990; Sanchez-Mejorada *et al.* 1986). Brack (Mesa Gardens, *in litt.* 1992) reports that cultivated specimens begin flowering after four years. Both populations need phenological observations during growing and dormant seasons to assess the species' response to varied climatic conditions. Observations at each visit should note present and recent climatic conditions at the time so that climatic data can be correlated with life cycle stages. This information would be necessary to determine management strategies to address vulnerable life stages and favorable times for establishment of individuals.

- 2.2.3 Study pollination biology. Sanchez-Mejorada *et al.* (1986) report star cactus as strictly sexually reproductive through outcrossing; therefore, understanding the pollination biology of this species is critical to the establishment and maintenance of populations. The showy, large flower remains open only during the day and would likely attract bee pollinators; however, pollinators have not been observed for star cactus. Other insects such as bee-like flies, butterflies, moths or beetles may be pollinators (Damude and Poole 1990). Identification of specific pollinators is critical information necessary for management of the species and an evaluation of pesticide threats to pollinators.

Pollination studies for star cactus should include insect visitation, pollinator effectiveness, pollen predation and viability, the potential maximum population density necessary for pollinator attraction and adequate pollen flow, and an assessment of the potential for pollination factors limiting the species' reproduction.

- 2.2.4 Study seed production and dispersal in the wild. Seed production and dispersal mechanisms in the wild are poorly understood. Mature fruits disintegrate while still attached to the plant and leave a small cluster of shiny, brown seed on top of the plant. It is likely that wind and rain carry the seed to establishment sites. Small rodents may also gather and store the seed. Ants may play a role in seed dispersal, either directly or indirectly, through seed or fruit herbivory. Ants have been observed in mature fruits, although there is indication that ants are eating the funiculus rather than the seed. Steven Brack (Mesa Gardens, *in litt.* 1992) notes from cultivated specimens that each fruit produces approximately 40 seeds which can remain viable for almost 10 years when stored under cool, dry conditions. This type of information from plants in the wild could prove invaluable in determining recruitment potential and long-term survivability for the species.
- 2.2.5 Study seedling recruitment. While seedlings have been observed in the wild, little is known about conditions necessary for seedling growth. Studies are needed to determine optimum conditions for seedling establishment and growth, effects of climatic factors on seedling growth, effects of disease and predation on seed production, and habitat factors that may be limiting seed production and seedling establishment.
- 2.2.6 Study population genetics to determine genetic diversity within and among populations. As populations are located or reintroduction projects materialize, the need for genetic information becomes invaluable. This

information would be useful in measuring the amount of genetic diversity of individuals within and among populations, total genetic diversity among all populations, and the genetic distance between two populations. In addition, information on the rate of gene flow between populations, as well as quantitative information on reproduction modes (self-fertilization vs. outcrossing vs. vegetative cloning) will help guide long term conservation strategies for the species.

- 2.3 Develop management/monitoring programs for existing and reintroduced populations. Management plans should be part of any stewardship agreement, Federal, State, or other protection provided for the star cactus. Management should address relevant threats to the species such as habitat loss or degradation. For example, pasture improvements, such as the introduction of non-native forage grasses, mechanical or chemical brush removal, or an increased animal stocking rate, could impact the species and/or its habitat. As information becomes available about the life history, ecology, and population biology of this species and its threats, it should be incorporated into management plans.

Monitoring should be incorporated into management planning. When possible, monitoring techniques should be standardized so that results between populations at different locations will be comparable. For instance, monitoring procedures for assessing reintroduction success should be coordinated with those implemented for naturally existing populations so that comparisons are verifiable and valid. The results from monitoring programs should enable an evaluation of management practices (i.e., adaptive management), as recovery progresses. Factors to be assessed during monitoring include the general condition of the habitat, plant numbers and distribution, size or age class, mortality and health of the populations including collection pressures, reproductive success, threats, and responses to management practices. Monitoring should be conducted at least three times annually during and following flowering and fruiting. Any decline noted in the species' condition during monitoring should be brought to the attention of the Service, TPWD, managers, recovery team, landowners, and other stakeholders involved in the species' recovery, so that an effective response is possible.

At the five-year evaluation of the Plan (i.e., Step-down Action 7), initiation of a Recovery Team to work with stakeholders to formulate management and monitoring options for the future should be strongly considered, if not already in place.

3. Search for new populations. Following a more detailed determination of community associations and habitat profiles, surveys for the star cactus should be conducted to locate

unidentified populations in the United States and Mexico. There are many areas of native habitat that have not been surveyed for this species due to lack of access on private lands. Additionally, this species is difficult to detect without an intensive search due to almost perfect camouflage within its habitat. Federal and State agency field personnel should be trained in survey methodology for star cactus and should be educated about its status and collection threats.

4. Establish a botanical garden population and seed bank; capture baseline genetic data.
With cooperation from landowners, plants from known populations in the United States and Mexico should be maintained at different institutions. A seed bank has been established through the auspices of the Center for Plant Conservation and maintained at the San Antonio Botanical Garden and the National Seed Storage Laboratory in Fort Collins, Colorado. One or more refugia collections and seed bank reserves should be established and maintained to provide assurance against extinction if a loss of the natural population should occur. Cultivated plants could also provide individuals for research efforts and possible reintroduction. Genetic considerations, such as maladaptive genes and hybridization, should be assessed and protocols established to guide botanical garden and seed bank management standards. In addition, baseline genetic information from known populations of star cactus would be beneficial in managing the threat of illegal collection of star cactus from the wild. The information would help determine from where plants were collected; if the genetic information matched a known protected population, then legal action may be taken. If the genetic information does not match any of the baseline data we can assume that there are unrecorded populations.
5. Establish new populations in natural habitats as necessary to meet downlisting criteria.
Due to the perceived rarity of star cactus, reintroduction of the species may be necessary to aid recovery. The Service defines reintroduction as placing species in the general range where they occurred historically. As some of the collection data for this species is ambiguous, any reintroduction will need to be undertaken in areas of appropriate habitat within the historic range of the species. Reintroduction efforts could be implemented on Federal lands such as those within the Lower Rio Grande Valley National Wildlife Refuge Complex in Texas or on State or private lands volunteered for use. Any reintroduction efforts will follow Service policy on controlled propagation of endangered and threatened species. As star cactus is easy to grow from seed and propagation techniques are well understood, a separate cultivation study is not needed (Martin *et al.* 1971, Backeberg 1977, Pilbean 1987, Minnich and Hutflesz 1991). As any reintroduction project develops, the most recent reintroduction guidelines available should be incorporated into the project plans (Falk, Millar, Olwell, EDS. 1996). Reintroduction programs should be incorporated into applicable agency land management plans. Reintroduction success should be assessed through the development and implementation of a long-term monitoring program.

6. Develop and implement a formal conservation agreement for star cactus, between the United States and Mexico. The star cactus spans the border between the United States and Mexico. Protective measures for the species in both countries are important for an overall conservation strategy. A formal conservation agreement between the United States and Mexico could have significant benefits for the recovery program, as adequate protection and conservation in both countries will be assured. Details of the agreement should be developed between the Service's Trilateral Agreement representative and relevant partners in the United States and Mexico.
7. Develop a public information and awareness program. Public education is one of the most important elements of the recovery process for a species facing collection threats. Public awareness and cooperation are essential for the success of the star cactus recovery program. An informative program about star cactus, its recovery plan, the collection threat to the species, and the ESA in general, should be developed for presentation to private landowners, agency personnel, and other interested groups. The program should include the identification of recovery tasks that the individuals or groups being addressed can accomplish to participate in recovery of the species. Additionally, information on star cactus should be included within any Lower Rio Grande Ecosystem program so that a coordinated approach to recovery can be implemented. Develop outreach programs with the Native American Church and licenced peyoteros, peyote harvesters, and private landowners on the importance of preserving the star cactus (as well as peyote, which is also a declining species).
8. Evaluate progress toward recovery, management direction, and status of information needed to develop delisting criteria, within five years (2008-9). Due to the critical need for information gathering and synthesis for development of the overall recovery strategy of star cactus, the Plan will be evaluated in five years. At this time, new information will be incorporated as appropriate, including research and survey results, and reintroduction progress. Changes in management direction will be made, if needed, and development of delisting criteria and a post-delisting monitoring plan will be considered. As required by section 4 (g) of the ESA, post-delisting monitoring must be conducted for a minimum of five years.

REDUCTION OR ALLEVIATION OF THREATS TO THE STAR CACTUS THROUGH IMPLEMENTATION OF RECOVERY ACTIONS

The final rule listing the star cactus as endangered under the ESA evaluated threats to the species in terms of the five ESA listing factors. Similarly, the standard for delisting must find that the same factors no longer threaten the species. It is therefore important for the Plan to clearly demonstrate that the actions recommended for recovery relate to the five factors. Implementation of the recovery actions recommended in the Plan would minimize these threats as follows:

Listing Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range. Several common range management practices threaten the present habitat of star cactus. Root-plowing or other mechanical or chemical brush clearing activities, introduction of aggressive exotic grass species such as buffelgrass, suppression of the natural fire cycle, and excessive livestock numbers may all contribute to the decline of the species. Roadway construction and further development of municipalities as roadways improve could reduce the amount of star cactus populations by eliminating habitat. Insecticides may reduce pollinators, and herbicides may reduce the number of the star cactus that are adjacent to roadways and within rangeland. Habitat where the star cactus is present in Mexico has been put into production for corn and citrus. Implementation of recovery actions 1.1, 1.2, 2.1, 3.1, 5, 6, and 7 will help to protect the star cactus' habitat by providing landowners and land managers education on the significance, rarity and threats facing the cactus; encouraging establishment

of Stewardship Agreements in coordination with short-term and long-term land use goals; developing management and monitoring plans with willing landowners and land managers; studying effects of land use patterns on star cactus and associated habitat; searching for additional populations on private, State and Federal lands, in the United States and Mexico; establishing new populations on private, State, and Federal lands; and promoting conservation of the species in the United States and Mexico by developing general public awareness.

Listing Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes. Star cactus is highly prized by cactus collectors for its unusual appearance. It has been in cultivation since the 1930s, although it is suspected that wild plants are still being collected. Implementation of recovery actions 1.1, 1.2, 6, and 7 will be used to educate the public on the importance of protecting the wild populations from collecting pressures, the importance of buying and/or selling only star cactus that have been propagated from seed, and initiating a plan to develop a point of contact within the Service so that new populations can be documented and protected from collection.

Listing Factor C: Disease or Predation. Little is known about diseases or predation on the star cactus, although there is some indication from recent surveys that rodents or lagomorph species may prey on star cactus. Exclosure units may help in deterring herbivores using the cacti for moisture or food. Drought within the last few years may have reduced the ability of star cactus to successfully set seed and may decrease new seedling growth. Studies under the implementation of recovery actions 2.1.3.2

and 2.1.3.3 will help to determine if drought conditions, freezing, flooding, and/or fire would reduce growth and reproduction.

Listing Factor D: The Inadequacy of Existing Regulatory Mechanisms. Protection of the star cactus under the ESA provides mechanisms to recover the species. Other regulatory mechanisms identified herein to recover the star cactus are described in recovery action 1.3. Recovery action 1.3 will continue the ongoing efforts of section 7 consultation, whereby Federal agencies are required to consult with the Service on projects that they fund, authorize, or permit on any projects that may disturb native habitat and possibly reduce the numbers of listed species. Recovery implementation actions 1.2, 2, 4, and 5 would enable additional recovery benefits by increasing the interests of non-governmental organizations, other Federal and State agencies, and academic institutions in searching for populations, performing research activities, establishing seed banking projects, and creating reintroduced populations. Action 7 will address binational conservation efforts and will strengthen existing partnerships.

Listing Factor E. Other Natural or Manmade Factors Affecting its Continued Existence. In the final listing of the star cactus, only one population composed of 2,100 plants was known to occur. Location of additional populations will increase our knowledge of the genetic variability and viability of the species, and appropriate management responses. It may also be necessary to reintroduce populations to increase the number of individuals of this species remaining in the wild. All recovery actions (1-8) directly or indirectly address this threat.

IMPLEMENTATION SCHEDULE

The following Implementation Schedule outlines actions and costs for the star cactus recovery program. It is a guide for meeting the objectives elaborated in Part II of this Plan. This schedule indicates action numbers, priorities, descriptions, duration, potential partners, and estimated costs. These actions, when accomplished, should allow for reclassification of star cactus to threatened status. The costs estimated are intended to assist in planning. The time estimated to reclassification as threatened is 10 years. However, due to the potential for downlisting to occur somewhat sooner due to the discovery of existing populations, and the need to reevaluate management strategies, costs have been estimated for five years, with remaining estimates in the “Comments” field. Costs of full recovery can not yet be estimated, as actions needed to delist the species have not been fully determined. This recovery plan does not obligate any involved agency to expend the estimated funds. Although cooperation and collaboration with private landowners is suggested in the recovery plan, private landowners are also not obligated to expend any funds.

Action Priority

Priority of recovery actions is based on the following ranking system: Actions with a value of 1 are necessary to prevent extinction or irreversible decline of the species in the foreseeable future; actions with a value of 2 are necessary to prevent a significant decline in species population/habitat quality, or some other significant negative impact, short of extinction; and actions with a value of 3 include all other actions necessary to meet recovery objectives.

Acronyms Used

CPC - Center for Plant Conservation
EPA - Environmental Protection Agency
ES - Ecological Services, U.S. Fish and Wildlife Service
FWS - U.S. Fish and Wildlife Service
LE - Law Enforcement, U.S. Fish and Wildlife Service
NRCS - Natural Resources Conservation Association
SABG - San Antonio Botanical Gardens
NWRS- U.S. Fish and Wildlife Service National Wildlife Refuge System
TAMU - Texas A&M University
TNC - The Nature Conservancy
TPWD - Texas Parks and Wildlife Department
TXDOT - Texas Department of Transportation
USDOT - United States Department of Transportation
UAT - Universidad Autónoma de Tamaulipas
UNAM - Universidad Nacional Autónoma de Mexico
UNL - Universidad de Nuevo Leon
UT-Pan - University of Texas - Pan American

STAR CACTUS RECOVERY PLAN IMPLEMENTATION SCHEDULE

Priority	Action #	Action Description	Action Duration	Responsible/Potential Partners			Year 1	Year 2	Year 3	Year 4	Year 5	Comments
				FWS		Other						
				Region	Program							
1	1.1	Landowner involvement and outreach.	1-10+	2	ES NWRS	NRCS TNC TPWD	3.0	3.0	3.0	3.0	3.0	Continue to provide information to landowners for protection of the cactus
1	1.2	Develop and implement star cactus stewardship agreements with voluntary landowners whose long and short term land-use goals are compatible with star cactus recovery needs.	1-10+	2	ES	TNC TPWD NRCS	9.0	4.0	4.0	4.0	4.0	Cost will depend on # of populations found on private land and willingness of landowners to promote star cactus recovery. Costs may continue through Year 10 at an approximate cost of \$4,000/year.
1	1.3	Enforce applicable laws and regulations.	Ongoing	2	ES LE NWRS	TPWD	1.0 1.0 1.0	1.0 1.0 1.0	1.0 1.0 1.0	1.0 1.0 1.0	1.0 1.0 1.0	Ongoing as needed throughout recovery program; may increase as information on threat of illegal collection is quantified.
2	2.1.1	Study soils and underlying geology.	2	2	ES NWRS	TPWD TAMU UT-Pan TNC	1.0	1.0	1.0	--	—	

Priority	Action #	Action Description	Action Duration	Responsible/Potential Partners			Year 1	Year 2	Year 3	Year 4	Year 5	Comments
				FWS		Other						
				Region	Program							
2	2.1.2	Determine community structure.	3	2	ES NWRS	TAMU TPWD TNC UT-Pan	5.0	5.0	5.0	--	—	
1	2.1.3.1	Study effects of land use practices on star cactus and its associated habitat.	5	2	ES NWRS	EPA NRCS TXDOT USDOT TPWD TAMU UT-Pan TNC	5.0	5.0	5.0	2.0	2.0	
2	2.1.3.2	Study interactions with other species.	3	2	ES NWRS	NRCS TPWD TNC TAMU UT-Pan	2.0	2.0	2.0	--	—	
3	2.1.3.3	Study responses to periodic or cyclic processes such as flooding, fire, drought, and freezing temperatures.	5	2	ES NWRS	TAMU TPWD TNC UT-Pan	2.0	2.0	2.0	2.0	2.0	
1	2.2.1	Conduct demographic analysis of the populations.	2	2	ES NWRS	NRCS TPWD TNC TAMU UT-Pan	10.0	10.0	—	—	—	

Priority	Action #	Action Description	Action Duration	Responsible/Potential Partners			Year 1	Year 2	Year 3	Year 4	Year 5	Comments
				FWS		Other						
				Region	Program							
2	2.2.2	Characterize phenology	5	2	ES NWRS	TAMU TNC TPWD UT-Pan	3.0	3.0	3.0	3.0	3.0	
2	2.2.3	Study pollination biology.	5	2	ES NWRS	TPWD TNC TAMU UT-Pan	5.0	5.0	5.0	5.0	5.0	
2	2.2.4	Study seed production and dispersal in the wild.	5	2	ES NWRS	TPWD TNC TAMU UT-Pan	3.0	3.0	3.0	3.0	3.0	
2	2.2.5	Study seedling recruitment.	5	2	ES NWRS	TPWD TNC TAMU UT-Pan	3.0	3.0	3.0	3.0	3.0	
2	2.2.6	Research genetics	5	2	ES NWRS	TAMU UT-Pan TPWD	30.0	30.0	30.0	--	--	
2	2.3	Develop management/monitoring programs for existing and reintroduced populations.	1-10	2	ES NWRS	NRCS TPWD TNC UT-Pan TAMU	13.0	8.0	8.0	8.0	8.0	Development of management/monitoring programs should continue as needed.

Priority	Action #	Action Description	Action Duration	Responsible/Potential Partners			Year 1	Year 2	Year 3	Year 4	Year 5	Comments
				FWS		Other						
				Region	Program							
1	3	Search for new populations.	Ongoing	2	ES NWRS	NRCS TPWD UAT / UNAM TAMU UT-Pan	4.0 2.0	4.0 2.0	4.0 2.0	4.0 2.0	4.0 2.0	Surveys should continue as needed.
1	4	Establish a botanical garden	Ongoing	2	ES NWRS	CPC SABG	2.0 2.0	2.0 2.0	2.0 2.0	—	—	
2	5	Establish new populations if necessary.	1-10	2	ES NWRS	TNC TPWD CPC	5.0	5.0	5.0	5.0	5.0	Costs may continue through Year 10, as necessary.
2	6	Develop and implement a formal conservation agreement for star cactus between the United States and Mexico.	1-10	2	ES NWRS	UNAM UAT UNL Other inter- ested parties.	--	—	—	—	—	Cost estimates will be developed when interested parties have been identified; would include meeting/travel cost.
1	7	Develop a public information and awareness program.	3	2	ES NWRS LE	NRCS TPWD UNAM UAT TNC	1.5 - 0.5	1.5 - 0.5	1.5 - 0.5	—	—	

Priority	Action #	Action Description	Action Duration	Responsible/Potential Partners			Year 1	Year 2	Year 3	Year 4	Year 5	Comments
				FWS		Other						
				Region	Program							
3	8	Evaluate progress toward recovery, management direction, and status of information needed to develop delisting criteria within five years.	1-10	2	ES NWRS	NRCS TPWD TNC UAT/ UNAM UNL other	—	—	—	—	—	Cost of this action can not be estimated until progress in Actions 1-6 is achieved. If significant adaptation to management is not needed, costs will be negligible. If a recovery team is convened (or other significant action taken), costs could include meeting, travel, or related costs.

LITERATURE CITED

- Backeberg, C. 1977. Cactus Lexicon. Blandford Press, Poole, Dorset, United Kingdom.
- Barbour, M.G., J.H. Burk and W.D. Pitts. 1979. Terrestrial Plant Ecology. Benjamin Cummings Publishing Co., Inc. Menlo Park, California.
- Benson, L. 1969. Cactaceae. In C.L. Lundell and collaborators, Flora of Texas, Vol. 2. Texas Research Foundation, Renner.
- Benson, L. 1982. The Cacti of the United States and Canada. Stanford University Press, Stanford, California.
- Blair, W.F. 1950. The biotic provinces of Texas. Texas Journal of Science, 2(1):93-117.
- Britton, N.L. and J.N. Rose. 1922. The Cactaceae. Vol. 3: 183-184.
- Clover, E.U. 1932. *Astrophytum* in the United States. Desert Plant Life 5: 20-21.
- Correll, D.S. and M.C. Johnston. 1979. Manual of the Vascular Plants of Texas. University of Texas at Dallas, Richardson, Texas. 1881 pp.
- Damude, N. and J. Poole. 1990. Status report on *Echinocactus asterias* (= *Astrophytum asterias*). U.S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Falk, D.A. and K.E. Holsinger, eds. 1991. Genetics and Conservation of Rare Plants. Oxford University Press, New York.
- Falk, D. A., C. I. Millar, and M. Olwell, eds. 1996. Restoring Diversity: Strategies for Reintroduction of Endangered Plants. Island Press, Washington, D.C. 505 pp.
- Fleischner, T. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology Vol. 8 No. 3:629-644.
- Harper, J.L. 1977. Population Biology of Plants. Academic Press, New York. 892 p.
- Ledig, Thomas, F. 1986. Genetic Structure and the Conservation of California's Endemic and Near-Endemic Conifers. In: Conservation and Management of Rare and Endangered Plants. Proceedings from a Conference of the California Native Plant Society.
- Lemaire, C.A. 1868. Les Cactées. Librairie Agricole de la Maison Rustique, Paris.

- Mace, G. M., and R. Lande. 1991. In: Defining and measuring success. Restoring Diversity; Strategies for reintroduction of endangered plants. Island Press.
- Martin, M.J., P.R. Chapman, and H.A. Auger. 1971. Cacti and their cultivation. Winchester Press, New York.
- Martínez-Avalos, J. G., E. Gerado, and F. Garza Ocañas. 2002. (In Revision). Geographic distribution and conservation of Cactaceae in the northeastern Mexico region. Diversity and Conservation.
- Mason, C.T. Jr. and P.B. Mason. 1987. A Handbook of Mexican Roadside Flora. University of Arizona Press, Tucson. 380 pp.
- Minnich, W.S. and F. Hutflesz. 1991. Cacti and succulents for the amateur. Cactus and Succulent Journal (U.S.) 63:122-123.
- Nabhan, G.P. 1987. Nurse plant ecology of threatened desert plants. In: Conservation and management of rare and endangered plants. Ed. T.S. Elias. California Native Plant Society, Sacramento.
- National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, North Carolina. 2002.
- Nurdin, and T. E. Fulbright. 1990. Allelopathic effects of two grasses on seed germination of three wildlife food plants. Texas Journal of Agriculture and Natural Resources. Vol. 4.
- Pavlik, B. 1987. Autecological monitoring of endangered plants. In: Conservation and management of rare and endangered plants. Ed. T.S. Elias. California Native Plant Society, Sacramento.
- Pavlik, B. M. 1996. Defining and measuring success. In: Restoring Diversity; Strategies for reintroduction of endangered plants. Island Press.
- Pilbean, J. 1987. Cacti for the connoisseur: A guide for growers and collectors. Timber Press, Oregon.
- Poole, J. and B.L. Westlund. 1991. Cactus trade and collection impact survey. Texas Natural Heritage Program, Austin.
- Rzedowski, J. 1978. Vegetacion de Mexico. Editorial Limusa, Mexico City.
- Sanchez-Mejorada, H., E.F. Anderson, N.P. Taylor and R. Taylor. 1986. Succulent plant conservation studies and training in Mexico. World Wildlife Fund, Washington, D.C.

- Schlesinger, W.H., J.F. Reynolds, G.L. Cunningham, L.F. Huenneke, W.M. Jarrell, R.A. Virginia and W.G. Whitford. 1990. Biological Feedbacks in Global Desertification. *Science* Vol. 247:1043-1047.
- Thompson, C.M., R. Sanders and D. Williams. 1972. Soil survey of Starr County, Texas. U.S. Department of Agriculture.
- U.S. Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants; Final rule to list *Astrophytum asterias* (star cactus) as endangered. *Federal Register* Vol. 58, No. 199:53804.
- Weniger, D. 1984. Cacti of Texas and neighboring states. University of Texas Press, Austin.
- Wu, Ben X., and Fred E. Smeins. 1999. Multiple-scale habitat Models of rare plants: model development and evaluation. Final Report to Texas Department of Transportation.
- Zuccarini, J.G. 1845. Act. acad. monagr. *Echinocactus asterias*. Abb. Bayer. Akad. Wiss. Munchen 4(2):13.

APPENDIX A

**COMMENTS RECEIVED ON THE DRAFT STAR CACTUS RECOVERY PLAN
DURING STAKEHOLDER AND PUBLIC/PEER REVIEW IN 2002**

APR 22 2002 3:03PM

SOIL WATER CONSERVATION

NO. 0223 P. 1/1

STARR COUNTY SOIL AND WATER CONSERVATION DISTRICT #332
208 S. MORRIS STREET
RIO GRANDE CITY, TEXAS 78582
PH. NO. (956)487-5598 EXT. 3
FAX NO. (956)487-2414

Comment # 1 Star Cactus Recovery Plan
USFWS Facsimile

Response
1-1.

TO: Loretta Pressley

FAX #: (361) 994-8262

FROM: J. M. Villarreal - Dist/Teal

DATE: April 22, 2002

COMMENTS: The board of director would like to invite
you to their regular monthly meeting on May 9th 2002
regarding the "Star Cactus" - and given them a
better idea as to what to do and what to look for.

J. M. Villarreal

Please give me a call if you can make it.

THIS TRANSMISSION CONSISTS OF 1
PAGES (THIS SHEET INCLUDED).

United States Department of Agriculture



Natural Resources Conservation Service
13434 Leopard Street, Suite A-14
Corpus Christi, TX 78410

Phone: (361) 241-0609
Fax: (361) 241-0685

Loretta Pressly
U.S. Fish and Wildlife Service
Corpus Christi Ecological Services c/o TAMUCC
6300 Ocean Drive, Box 338
Corpus Christi, TX 78412

May 8, 2002

Comment # 2 Star Cactus Recovery Plan
US Postal Mail

Dear Ms Pressly:

I have reviewed the preliminary Draft Recovery Plan for the Star Cactus (*Astrophytum asterias*) as per Allan Strand's letter dated April 4, 2002. I appreciate the opportunity to review this recovery plan and offer the following comments.

Page iii, first paragraph, last sentence appears to have a duplication of part of a sentence.

Response
2-1.

Page 1, second paragraph, sentence 5 - "The star cactus...and clay soils." Is there any documented evidence that this cactus grows naturally on clay soils? In my experience, this type of cactus generally grows on well-drained loamy and/or gravelly soils. The two known locations referred to on page 5 support this observation.

Response
2-2.

Page 1, second paragraph, sentence 6 - "...conversion of native habitat to agricultural land ..." What is your definition of "agricultural land"? I am assuming that you are referring to lands that have been converted to non-native species, such as lands planted annually to cash crops, vegetables, etc., and/or orchards, vineyards, and introduced grasses.

Response
2-3.

Page 5, second paragraph, - If the only two known populations occur on areas where "the original vegetation has been significantly altered by range management practices of clearing and overgrazing", then is it possible that these two practices are beneficial to this plant? It is a well-documented fact that mechanical brush treatment methods increase most cactaceae species. Overgrazing, which we consider a range miss-management practice in most cases, would reduce the competition from native and introduced herbaceous species. This reduction in herbaceous vegetation would tend to take the microclimate toward the xeric and away from mesic, which is normally a more favorable habitat for cacti.

Response
2-4.

Page 9, first paragraph, - last sentence speaks about "a massive conversion of available native habitat to agriculture." There are almost no native grazing lands in Cameron County and the south half of Hidalgo counties. This southernmost part of the Rio Grande Plains is comprised almost entirely of heavy, flat, poorly drained clay soils. I doubt very seriously that it was ever a very good habitat for this cactus species.

The Natural Resources Conservation Service provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment.

An Equal Opportunity Provider and Employer

United States Department of Agriculture



Natural Resources Conservation Service
13434 Leopard Street, Suite A-14
Corpus Christi, TX 78410

Phone: (361) 241-0609
Fax: (361) 241-0685

Response
2-5.

Page 10; last paragraph - "Habitat destruction and modification are the primary threats to star cactus." As I stated before, mechanical brush management techniques such as rootplowing, increase the populations of cacti species, further supported by the following sentence, "These types of land management practices have been implemented in the past..."

Response
2-6.

Page 11, first paragraph - "excessive livestock numbers may have significantly altered or destroyed available habitat for the species (Damude and Poole 1990)". How? "...habitat is increasingly threatened by urban development..." I believe that this, with collection, is the real threat to any of the small cacti species, especially those that resemble peyote.

Response
2-7.

Page 11, second paragraph - "these sites are threatened by overgrazing, primarily by cattle and goats, which is altering the natural plant community present (Sancheq-Mejorada et al. 1986)." Again, I ask how? How are these sites threatened by overgrazing when overgrazing removes herbaceous vegetation? The cattle are reducing the competition for the species.

Response
2-8.

Page 11, third paragraph - "Another major threat to star cactus is collection of plants from the wild." I believe this to be **THE** major threat to this species.

Response
2-9.

Part II Recovery - Excellent ideas for recovery. Working with landowners and developing stewardship agreements have worked well in the past (Johnston's Frankenia in Starr and Zapata counties). When land managers are aware of the resource that they have they tend to do more to protect and enhance these populations that what untold amount of laws and regulations can do.

Response
2-10.

Page 31-32 - "Buffelgrass can displace native vegetation and possibly create changes in the surrounding habitat through allelopathic mechanisms..." This is the first that I have heard that buffelgrass is allelopathic. I can find no reference in the literature supporting this statement. Buffelgrass, as do many aggressive species, abhors a vacuum and aggressively fills the voids.

Page 32, second paragraph, first sentence - "Although cattle are not known to graze star cactus, grazing and trampling may cause direct..." There seems to be a huge assumption made from "not known" to causing all of the negative effects listed.

Again, thank you for allowing me to comment.

Mike Black,
Program Liaison, NRCS, Corpus Christi, TX

The Natural Resources Conservation Service provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment.

An Equal Opportunity Provider and Employer



U.S. Department
of Transportation
**Federal Highway
Administration**

U.S. FISH & WILDLIFE SERVICE

MAY 29 2002

CORPUS CHRISTI, TEXAS

Texas Division Office
300 East 8th Street, Rm. 826
Austin, Texas, 78701

May 21, 2002

In Reply Refer To: HPP-TX

**Comment # 3 Star Cactus Recovery Plan
US Postal Mail**

Star Cactus (*Astrophytum asterias*) Draft Recovery Plan

Ms. Loretta Pressly
U.S. Fish and Wildlife Service
Corpus Christi Ecological Services
c/o TAMUCC
6300 Ocean Drive, Box 338
Corpus Christi, Texas 78412

Dear Ms. Pressly:

The Federal Highway Administration (FHWA) has the following comments on the Draft Recovery Plan, which was submitted to us for review by Mr. Allan Strand's letter dated April 4, 2002, to Mr. Jesse Gray.

Response
3-1.

The Recovery Plan states that there is a need for more research and data gathering to determine the specific impacts of pesticides on the Star Cactus (page 35). Until that supporting data is available, the FHWA believes it is inappropriate to say (on pages 10 and 11) "...current right-of-way management practices using pesticides or herbicides, pose a threat to star cactus." We request that this sentence be revised to refer to a "potential" threat.

The Texas Department of Transportation (TxDOT) Maintenance Division reports there is very little use of herbicides on right of way in the area where Star Cactus occurs. Before the Recovery Plan is finalized, we suggest that the USFWS review, with TxDOT, the herbicide use on the highway right of way in the area where the species occurs. We also suggest a review of the label data and supporting literature for the herbicides being used. This effort could lead to removing the statements about herbicides and the requirement for research on the effect of herbicides. If it reveals that there is a problem with current programs, they could potentially be corrected without the expense of research. The results of this effort would provide factual data upon which the USFWS and we could rely for inclusion in the Recovery Plan.

As noted in the Draft Recovery Plan, the only known population(s) of star cactus is on private land. The Texas Department of Transportation has no history of ESA compliance involvement with the species. TxDOT did contract a study for development of a predictive model of habitat for rare plants in the lower Rio Grande Valley areas of Texas. Star cactus was included in that study. Therefore, TxDOT has a description of suitable habitat to use when evaluating project areas for potential listed species occurrence.

2

Since the Star cactus is also listed as a State endangered species, we are confident that our partner, the Texas Department of Transportation, also complies with the requirements of the Endangered Species Act and the Lacey Act by following its current policies, procedures and practices.

We believe our current policies, procedures and practices enable us to comply with the Endangered Species Act and related species recovery plans. The Federal Highway Administration is committed to working with the Texas Department of Transportation and the USFWS Corpus Christi Office to facilitate the recovery of the Star Cactus within the State of Texas.

Also, we request that TxDOT be included in future requests for review and comment on draft and/or final recovery plans. Their address is: Ms. Dianna Noble, P.E., Director, Environmental Affairs Division, 125 East 11th Street, Austin, Texas 78701-2483. Finally, Mr. Jesse Gray has retired from the FHWA. Future correspondence to the FHWA Division Office should be addressed to the Director, Planning and Program Development. I am enclosing an organizational chart for your use in contacting our staff. Please feel free to call us if we can provide further assistance.

Sincerely,



Irene Riço

Director, Planning and Program Development

Enclosure

cc: Ms. Dianna Noble, P.E.
Director, Environmental Affairs Division
Texas Department of Transportation

Texas General
Land Office



David Dewhurst
Commissioner

Response
4-1.

Mailing:
Post Office Box 12873
Austin, Texas
78711-2873

Street:
Stephen F. Austin Building
1700 North Congress Avenue
Austin, Texas 78701-1495

512.463.5001
1.800.998.4GLO
www.glo.state.tx.us

October 30, 2002

Comment #4 Star Cactus Recovery Plan
US Postal Mail

Mr. Allen Strand
Field Supervisor
U.S. Fish and Wildlife Service
TAMU-CC, Campus Box 338
6300 Ocean Drive
Corpus Christi, TX 78412-5599

Dear Mr. Strand:

Thank you for the opportunity to comment on the U.S. Fish and Wildlife Service's Draft Recovery Plan for the Star Cactus, *Astrophytum asterias*. The Land Office believes that implementation of recovery measures listed in the Plan will help conserve this endangered species.

Please contact me at 512-463-5100 or at thomas.calnan@glo.state.tx.us if you need additional help or have any concerns.

Sincerely,

A handwritten signature in cursive script that reads "Thomas R. Calnan".

Thomas R. Calnan
Coastal Biologist

TRC/tc

RECEIVED

NOV 04 2002

FISH & WILDLIFE SERVICE
CORPUS CHRISTI, TX

Comment # 5 Star Cactus Recovery Plan
US Postal Mail



UNITED STATES
DEPARTMENT
OF AGRICULTURE

NATURAL RESOURCES
CONSERVATION
SERVICE

KIKA DE LA GARZA PMC
3409 N. FM 1355
KINGSVILLE, TX 78363
361-595-1313

November 4, 2002

RECEIVED

NOV 01 2002

Field Supervisor
U.S. Fish and Wildlife Service,
Corpus Christi Ecological Services
c/o TAMU-CC
6300 Ocean Drive, Box 338
Corpus Christi, TX 78412

**FISH & WILDLIFE SERVICE
CORPUS CHRISTI, TX**

Attention: Loretta Pressly

Subject: Draft Star Cactus Recovery Plan – comments

Our Center recently received a draft copy of the Star Cactus Recovery Plan for review and comments. First of all, let me say that I think you did an excellent job in preparing this plan. I can see that it was the result of a lot of hard work. I hope it will receive enough funding to make it a work in progress. I had just a few thoughts after reading over the plan, and would like to submit them for your consideration.

Response
5-1.

- I would suggest obtaining a DNA sample from every plant in both the U.S. and Mexico populations, or at least a representative sample. This will give you an idea of the genetic diversity you are dealing with. Also, when illegally collected plants are found, you will be able to tell which population they came from. If they match either of the populations, this may assist in any legal action necessary. If they do not match these populations, then there must be other unrecorded populations somewhere.
- Under Population Biology you stated that juveniles have been observed growing up from the top of a dead parent plant. If DNA samples were collected from each of the juveniles in a group, they could be compared to tell if they all came from the same mother plant. If any good DNA can be obtained from the dead mother plant (which may not be possible, depending on the conditions), you will be able to tell immediately if the juveniles were produced sexually or vegetatively. If they were produced sexually, you should also be able to tell if they all came from the same pollen donor. This will give you clues to the pollination biology and also as to how much genetic diversity is produced per fruit.

Response
5-2.

- Under Collection you mention that peyote collectors sometimes mistakenly collect star cactus. Since these two cacti occur in the same habitat, these collectors



Visit the Plant Materials Program website at:
<http://Plant-Materials.nrcs.usda.gov>

PLANT SOLUTIONS FOR CONSERVATION NEEDS

The USDA is an Equal Opportunity Employer



UNITED STATES
DEPARTMENT
OF AGRICULTURE

NATURAL RESOURCES
CONSERVATION
SERVICE

KIKA DE LA GARZA PMC
3409 N. FM 1355
KINGSVILLE, TX 78363
361-595-1313

would be a priority group to contact and educate to look for more populations of star cactus. I would guess that they would need some kind of assurance that (a) their livelihood is not being threatened and that (b) the government will have to gain the property owners permission before taking any action. Even if you could not obtain access to these new populations, at least you would know they exist. Also, I would try to work out a deal to obtain the "peyote rejects" that the collectors accidentally bring in and discard. Again, this may require assuring the collectors that they will not be fined for any accidents. However, the deal must not be lucrative enough to encourage digging up star cactus on purpose. If the collectors will provide you with the rejects, but not the location of their origin, DNA matching them to the known populations will tell if they came from either of these sites. Also, by comparing the DNA of rejects to each other, you may be able to estimate how many populations were harvested.

These may be things you have already considered, but were just too detailed to include in the recovery plan. Thank you for asking us for our ideas.

Respectfully,

A handwritten signature in black ink, appearing to read "Shelly D. Maher".

Shelly D. Maher
Research Scientist



Visit the Plant Materials Program website at:
<http://Plant-Materials.nrcs.usda.gov>

PLANT SOLUTIONS FOR CONSERVATION NEEDS

The USDA is an Equal Opportunity Employer

Comment # 6 Star Cactus Recovery Plan
US Postal Mail



OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

NOV 5 - 2002

RECEIVED

NOV 06 2002

FISH & WILDLIFE SERVICE
CORPUS CHRISTI, TX

Mr. Allan M. Strand
Field Supervisor
U.S. Fish and Wildlife Service
Attn. Loretta Pressly
Corpus Christi Ecological Services
c/o TAMU-CC,
6300 Ocean Dr., Box 338
Corpus Christi, Texas 78412

Dear Mr. Strand:

Thank you for the opportunity to comment on the *Draft* Recovery Plan for the Star Cactus (*Astrophytum asterias*). The United States Section of the International Boundary and Water Commission (USIBWC), is interested in the recovery efforts of the endangered Star Cactus, especially in the areas near the Rio Grande flood control projects in south Texas. We anticipate that USIBWC activities in the lower Rio Grande would not have any impacts on the recovery efforts since the preferred soil types are probably located on the second and third terraces and generally not within 200-300 feet of the river.

Response
6-1.

The USIBWC intends to continue the current maintenance activities and possibly expand these practices in the future with appropriate required coordination with the United States Fish and Wildlife Service (USFWS). The USIBWC could survey the proposed maintenance tracts, if soil, vegetation and elevation data indicate potential habitat exists. This would help the USFWS satisfy one of the proposed recovery measures. In addition, the USIBWC could also survey for the plant during future Migratory Bird Treaty Act surveys. Qualified biologists cognizant of the star cactus and other species habitat requirements would note any specimens observed during the bird surveys and inform the USFWS.

In the future, please address documents of this type to Commissioner Carlos M. Ramirez, P.E., at the same letterhead address. Also please provide the USIBWC a copy of the final recovery plan once it is complete. Again, I want to thank you for the opportunity to comment on the draft plan. If you have any questions, please call Environmental Protection Specialist, Daniel Borunda at (915) 832-4701.

Sincerely,

for Sylvia A. Waggoner
Division Engineer
Environmental Management Division

The Commons, Building C, Suite 310 • 4171 N. Mesa Street • El Paso, Texas 79902
(915) 832-4100 • (FAX) (915) 832-4190 • <http://www.ibwc.state.gov>

Comment # 7 Star Cactus Recovery Plan
Email L. Pressly



Russell & Vicki Riley
<rriley@dm-tech.net>

To: Loretta_Pressly@fws.gov

11/06/2002 12:58 PM

Subject: starr cactus

Response
7-1.

U.S.F. & W. has no business whatsoever casting a public recovery plan for anything on PRIVATE PROPERTY! This whole ESA business should stick to public property, and allow private landowners to use their land. Hopefully, actions like this will eventually result in the reform of the ESA, a reform that needs to come very soon. The federal government has no business whatsoever putting restrictions on private land unless they intend to offer FAIR value for the land, and allow the landowner to recoup his capital and establish his farm or ranch in another location. Vicki Riley, P.O. Box 389, Douglas City, CA 96024

Comment # 8 Star Cactus Recovery Plan
Email L. Pressly



"Tim Fulbright"
<kftef00@tamuk.edu>
11/06/2002 01:45 PM

To: <Loretta_Pressly@fws.gov>
Subject: Star Cactus Recovery Plan

Loretta,

Response
8-1.

I just read the Star Cactus Recovery Plan. The document is very thorough and well written. It might help in the section on Morphology to describe some of the differences between Star Cactus and peyote, since they may be easily confused. Thank you for the opportunity to review the plan.

Tim Fulbright

Comment # 9 Star Cactus Recovery Plan
US Postal Mail



RECEIVED

NOV 11 2002

8 November 2002

FISH & WILDLIFE SERVICE
CORPUS CHRISTI, TX

COMMISSIONERS
KATHARINE ARMSTRONG IDSAL
CHAIRMAN, SAN ANTONIO

ERNEST ANGELO, JR.
VICE-CHAIRMAN, MIDLAND

JOHN AVILA, JR.
FORT WORTH

JOSEPH B.C. FITZSIMONS
SAN ANTONIO

ALVIN L. HENRY
HOUSTON

PHILIP MONTGOMERY
DALLAS

DONATO D. RAMOS
LAREDO

KELLY W. RISINS, M.D.
BEAUMONT

MARK E. WATSON, JR.
SAN ANTONIO

LEE M. BASS
CHAIRMAN-EMERITUS
FORT WORTH

ROBERT L. COOK
EXECUTIVE DIRECTOR

Ms. Loretta Pressly
U.S. Fish and Wildlife Service
Corpus Christi Ecological Services
c/o TAMUCC
6300 Ocean Dr., Box 338
Corpus Christi, TX 78412

Dear Loretta,

Thank you for allowing us the opportunity to comment on the draft recovery plan for the star cactus. Overall the plan is very well written, and for the most part, addresses the conservation and recovery of the species. However, we have a few comments concerning the distribution, threats, recovery criteria, actions and priorities, and budget. We have also learned of new information on the cactus in the past year. We suggest that this new information should be included to make the Recovery Plan more complete.

During the Lower Rio Grande Valley Rare Plant Expert Workshop held last January in Brownsville, Dr. Guadalupe Martinez Avalos mentioned that he and his students had found six small populations in Tamaulipas. He also stated that his students had found a population near Zapata. As these are recent records from knowledgeable individuals, they should be added to the distribution. We also have reports in our files of sightings in northern Jim Hogg County; near the Santa Margarita Ranch, in the vicinity of Escobares, and the airport north of Rio Grande City in Starr County; and the Bass and Kratz ranches, locations unknown. Although these unverified locations should not be added to the currently known occurrences, Jim Hogg County should be considered as a potential county of occurrence, and the localities in Starr County should be mentioned as possible locations. Thus there are records or reports to substantiate the potential occurrence of star cactus in Cameron, Hidalgo, Zapata, and Jim Hogg counties. While there is no evidence (to our knowledge) to corroborate potential occurrences in Webb County, the proximity to reported locations and the similarity of soils and vegetation do infer that star cactus may occur in the southern part of the county. However thorough habitat characterization of the

Response
9-1.



Take a kid
hunting or fishing

• • •

Visit a state park
or historic site

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512-369-4000

www.tpwd.state.tx.us

To manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations.

edaphic and vegetation features should be accomplished before surveying locations without nearby reported occurrences.

Undoubtedly habitat destruction/alteration is, and will continue to be, the major threat to star cactus. It should be mentioned in the Recovery Plan that the human population of all the above counties will increase dramatically over the next 50 years (i.e., projections are Cameron - 104%, Jim Hogg - 182%, Hidalgo - 256%, Webb - 260%, Starr - 324%, Zapata - 495%). An additional recovery action should be to study where human population growth will occur so that reintroduction can be avoided in high growth corridors.

Response
9-2.

Caution should be used when stating that fire suppression has detrimentally affected star cactus populations (p. 6, second paragraph). In Benson's Cacti of the United States and Canada, he states that "along the edges of the deserts and in the chaparrals and grasslands adjoining them, fire is a major threat, and the cacti can persist only in areas where a fire does not become particularly hot, as, for example, on rock outcrops or sandy flats or on hillsides without a dense cover of brush". While fire suppression may have altered the plant community within which star cactus is found, the direct effect of fire on star cactus, while unknown, may be negative (see Recovery Plan, p. 10, first paragraph).

Response
9-3.

The second major threat to star cactus continues to be collection. The recovery plan should address monitoring of known or reintroduced populations to determine the current extent of this threat. Education targeted specifically at cactus collectors should be a major part of the recovery plan including approaches to inform peyote dealers and other peyote collectors, as inexperienced harvesters collect star cactus. In Mexico star cactus has been inadvertently destroyed by the government in attempts to obliterate peyote populations. The Recovery Plan should mention the need to work with the Mexican government on this issue as part of the MOU (Action 6).

Response
9-4.

The number of populations required for downlisting has been changed from 15 in the preliminary draft to three. No reasons for this modification are given. Three populations are insufficient to protect against stochastic events, let alone the threats to star cactus from habitat destruction and collection. Also, until genetic studies have been completed we cannot assume that populations are genetically similar. It would be more judicious to base the number of required populations for downlisting on the number of reported populations (12 according to our records). This would better preserve the

Response
9-5.

Drought and fire are important sculptors of the landscape. They should be added to Actions 2.1.3 and 2.1.3.3. Drought affects reproductive output, establishment, and pollinator/disperser populations. Weather data should be collected at the site, not used from the closest town (see Action 2.2.2). Precipitation in particular is often dramatically different over just a few hundred meters. Fire may have a direct negative effect on star cactus. It should not be assumed that the habitat of star cactus is fire adapted.

Response
9-10.

Pollination biology (Action 2.2.3) is extremely important for many recovery actions. Star cactus is an out-crossing species, and thus pollinators are essential for its survival. Identification of effective pollinators, and not just floral visitors, will be necessary for selection of suitable reintroduction sites as well as for management of known sites.

Response
9-11.

While a workshop is mentioned for developing, prioritizing, and coordinating research priorities (Action 2), a working group or recovery team would seem better suited to these tasks. However a workshop on identification of the species and its habitat would be quite helpful in searching for new populations (Action 3). The invited audience should include not just agency personnel but also non-governmental organizations, consultants, landowners, and volunteer groups.

Response
9-12.

Monitoring (Action 2.3) should include plant size which should be measured during the driest (on average) time of the year to avoid erroneous readings from water-swollen plants. Also causes of mortality or disappearance should be recorded, particularly any loss thought to be due to collection. Quantifying the latter will be important to determine the site-specific threat from collection as well as the effectiveness of education programs.

The implementation schedule should be reprioritized. The priority 1 actions required to prevent extinction should include not only the protection of all known star cactus populations (Action 1), establishing a botanical garden population and seedbank (Action 4), and determining best land use practices (Action 2.1.3.1), but also public education (Action 7) with an added component aimed at collectors. Reintroduction (Action 5) and surveys for new populations (Action 3) are not as essential to the short-term survival of the species as protection and management; thus these actions should be priority two. Also reintroduction (Action 5) should not receive a higher priority than the actions leading to the identification of qualities needed for successful establishment of viable populations. The identification of soils and geology (Action 2.1.1), community

Response
9-13.

structure (Action 2.1.2), pollinators (Action 2.2.3) and potential dispersal agents (Action 2.2.4) should all be priority two as these subjects are essential to maintaining viable populations. These actions should all be completed before reintroduction is attempted. Correctly done reintroduction is an extremely time-consuming process. The selection of inappropriate sites wastes time and money that could be spent on other aspects of recovery. While developing a formal agreement for conserving star cactus between the United States and Mexico (Action 6) is important, actions on the ground will aid more in recovery. Action 6 should be lowered to priority three.

Texas Parks and Wildlife Department (TPWD), The Nature Conservancy of Texas, Natural Resources Conservation Service, and Texas Agriculture Extension Agency should be included in the Implementation Schedule's Responsible Parties for Action 1.1 (providing landowners with information on star cactus). These organizations have daily contact with hundreds of landowners, and will get the message out more quickly than just USFWS and the National Wildlife Refuge System. TPWD should also be added to the Responsible Parties for Action 1.2 (stewardship agreements) as TPWD writes wildlife and non-game species management plans for landowners on a regular basis.

Response
9-14.

A few items in the budget seem underfunded. The amount set for the study of soils and geology (Action 2.1.1) seems too low. Detailed soil samples are fairly expensive, and if several are done for each site (see p. 16), may easily cost more than \$1500. It would also be useful to have a soil scientist visit the site. Perhaps a total of \$3000 split over three years would be more adequate. Under Action 3 (search for new populations), the budget for UNA appears to be zero.

Response
9-15.

The Questions and Answers sheet for the Recovery Plan is a very good idea, although the exact purpose and the audience were not explained in the cover letter. As the Q&A sheet may stand alone, a layman's description of star cactus, the range, and habitat would be helpful. In addition to the prohibitions, there should also be suggestions as to what a landowner can do, such as normal management procedures that do not require federal funding, etc. Also the Q&A sheet might benefit from a different organization with the description of star cactus and reasons for endangered status coming first, followed by landowner information, and ending with recovery. The recovery section should place more emphasis on the various ways in which star cactus could be delisted, and less on reintroduction.

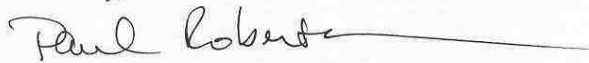
Response
9-16.

The other fact sheet (with the color photograph of star cactus) that was included with the Recovery Plan contains a few minor errors. There is nothing after the Distribution heading. Zapata County should be added to the Historic Presence. The site was GPSed by students of Dr. Martinez Avalos. Echinocactus is misspelled in the Other Information section.

Finally there are a few minor corrections. The accepted way according to the International Code of Botanical Nomenclature to state species authorities are *Astrophytum asterias* (Zuccarini) Lemaire. Some exceptional specimens of star cactus grow to 10" in diameter. Flowering may also occur in the summer especially after adequate rainfall. Texas Parks and Wildlife Department should be added to Action 1.3 under the discussion of trade permits as TPWD issues permits for both scientific research and commercial trade in listed species. In Action 2.1.3.3 it is stated that part of a sub-population occurs near an area that occasionally ponds water. Is this referring to plants that are near a failed man-made stock tank, or is this a natural phenomenon? The last sentence on Listing Factor 4 is incomplete.

Thank you again for allowing us to review the star cactus Recovery Plan. If you have any questions, please call either Jackie Poole or Dana Price of our staff.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul Robertson", followed by a long horizontal line extending to the right.

Paul Robertson
Science Leader, Wildlife Diversity Program
Texas Parks and Wildlife

Comment # 10 Star Cactus Recovery Plan
Email L. Pressly

Peer Reviewer

Martin Terry, DVM, PhD
Department of Biology
Texas A&M University
College Station, TX 77843-3258

15 November 2002

Mr. Allan M. Strand
Fish and Wildlife Service
Ecological Services
c/o TAMU-CC, Campus Box 338
6300 Ocean Drive
Corpus Christi, TX 78412

Dear Mr. Strand:

Re: Star Cactus Draft Recovery Plan

Thank you for your letter of 17 October 2002 soliciting review and comment on the star cactus (*Astrophytum asterias*) draft recovery plan of the same date. In general I find the draft to be well written and reasonably complete. My specific comments follow.

Page 6, 1st para, threat (4): The sense would be clearer if it were rewritten as follows:
“(4) Reduction of genetic variability (and possibly viability) through diminution of population size through loss and/or modification of habitat, with a resulting increase in inbreeding and decrease in heterozygosity.”

Though “genetic considerations” are mentioned briefly on p. 21, para (4), the recovery plan would be strengthened scientifically by the insertion of a new paragraph entitled “Study population genetics to determine genetic diversity within and among populations.” This would logically go between the existing paragraphs 2.2.1 and 2.2.2 on p. 19. The text of such a paragraph is proposed as follows:

Response
10-1.

A rational program of reintroduction of star cactus into appropriate habitat in its historical range must take into account the genetic diversity among individuals within each known population, as well as the total genetic diversity among all known populations and the genetic distance between any two populations. Such information will provide guidance on the selection of the optimal population(s) and parent plants from which to produce seed for the reintroduction program in a given geographic area. Reliable information of this type can be obtained from a study using codominant genetic markers such as microsatellites. In addition, such a study may yield helpful information on the rate of gene flow between populations, as well as quantitative information on the mode(s) of reproduction (e.g., self-fertilization vs. outcrossing vs. vegetative cloning).

Page 20, para 3 ("Search for new populations") and p. 21, para 7 ("Develop a public information and awareness program"): One of the key groups that should be targeted in both these actions is the small group of licensed peyote distributors (peyoteros). It was correctly noted (page 7, 1st para) that star cactus has been harvested in error by the agents of the licensed peyote distributors because of its superficial resemblance to *Lophophora* (peyote) and the fact that the star cactus and peyote often grow in close proximity to each other in South Texas. So educational efforts are certainly in order for the contract harvesting agents of the peyoteros. But an additional reason to pay attention to the peyoteros is that they are knowledgeable about locations where undocumented populations of star cactus are likely to be found, and in many cases the peyoteros have cordial working relationships (and even family relationships!) with the landowners at such locations, which could provide an entrée that would greatly facilitate gaining access to the properties of interest.

One point that is not addressed anywhere in the recovery plan – and perhaps should not be – is the belief among some members of the public that the star cactus has psychoactive properties when ingested. There is no published literature on this subject, and no one knows how widely held that belief might be. But it could conceivably be helpful to the public information program to do a chemical study to show that, for example, the star cactus contains no mescaline (or other selected peyote alkaloids). Such a study could be done in a matter of a few months, using readily available instruments of chromatography and mass spectrometry.

I hope these comments are helpful in finalizing the recovery plan.

Yours very truly,

Martin Terry, DVM, PhD



APPENDIX B

RESPONSES TO COMMENTS TODRAFT STAR CACTUS RECOVERY PLAN

RESPONSE

A Draft Star Cactus Recovery Plan (Draft Plan) was distributed to stakeholders in April, 2002. The Service initially distributed 205 copies of the Draft Plan to State, Federal, and County agencies, universities in both the U.S. and Mexico, non-governmental agencies and individuals. The Service also sent out the same number of letters notifying local and national organization of the Draft Plan's availability for public review and comment. A request for comments was published in the Federal Register on Oct. 17, 2002. Peer review was requested from 5 individuals including Federal, university, non-governmental organizations, and a botanist from Mexico.

The Service has incorporated all comments into the Final Star Catus Recovery Plan and the following response section. All comments were considered when revising the Draft Plan. The Service appreciates the time that each of the commentors took to review the Draft Plan and to submit their comments.

The comments discussed below represent a composite of those comments received. Comments of a similar nature are grouped together. Substantive comments that question approach, methodology, or financial need called for in the Draft Plan, or suggest changes to the Draft Plan are discussed here. Comments received that related to the original listing decision and general comments about the Endangered Species Act that did not relate to star cactus are not discussed here. Comments that offered further clarification of detail and specificity in biological studies and simple editorial suggestions such as better wording, spelling or punctuation were incorporated as appropriate without discussion here. All comments received are retained as a part of the Administrative Record of the recovery plan in the Corpus Christi, Texas, Ecological Services Field Office.

Comment Letter # 1. Mr. J. M. Villarreal, Starr County Soil and Water Conservation District #332. April 22, 2002.

- 1-1. The Service appreciates your invitation to meet at the Starr County's Soil and Water Conservation District monthly meeting and look forward to working with you on the conservation of the star cactus.

Comment Letter # 2. Mr. Mike Black, Program Liaison, Natural Resources Conservation District Corpus Christi, USDA. May 8, 2002.

- 2-1. We agree that the one known location of star cactus is reported to be found on gravelly loams characteristic in the Jimenez-Quemado soil association. This area has probably changed over time by the movement of water and the erosion of soils on top of an underlying bedrock of calcium carbonate and rock. There is the likelihood that the plant would be found in various soils based on historical occurrences in both the United States and Mexico.

- 2-2. The term “*agricultural land*” includes both row/cash crop and/or rangeland. We have clarified this in the Final Recovery Plan.
- 2-3. We agree that further determination of the effects of alteration of habitat by range management practices of clearing and overgrazing is needed. Mechanical treatment for removal of brush species may indeed stimulate growth of some cacti species, although it is shown that disturbance to the star cactus does not greatly effectuate vegetative reproduction. Overgrazing, may indeed reduce the competition for nutrient, sunlight, and moisture availability, although it also effectuates erosion, transportation of soil and seed material to unfavorable sites and reduces the native quality of the habitat.
- 2-4. The Service agrees that there is little indication that the star cactus still exists in Cameron County except for the historical records. There is however, information that supports the presence of the cactus in the south-eastern portion of Hidalgo County, especially within the Pits-Jimenez-Quemado soils adjacent to Starr County. One of the most important criteria for discovering new populations of star cactus is to survey soil and vegetative characteristics of the known habitat. There is also information suggesting that the star cactus has been located in Zapata County near the Town of Zapata although this occurrence has not been re-verified.
- 2-5. See response to comment 2-3. (Habitat destruction and modification)
- 2-6. The Service agrees that collection is one of the major threats where historical populations were found since it was first discovered in 1842. There is however, much acreage that is utilized for ranching and hunting that contain the habitat where the star cactus occurs. Although the practice of root-plowing has decreased, much of the changes with urbanization and ranching activities are non-reversible. These non-natural changes increase disturbance of the natural habitat, allowing non-native species to move in creating a monotypic environment, thereby reducing the variability of the region’s resources. Interpreting impacts to the natural habitat where the star cactus occurs is addressed in Recovery Actions Nos. 2.1.1, 2.1.3.1 and 2.1.3.2.
- 2-7. See response to comment 2-6 (Habitat destruction).
- 2-8. As most of the land in Texas is owned by private citizens, it is imperative that we develop partnerships with landowners, therefore we would appreciate working with your office and other soil and conservation districts to further the protection of the cactus, other rare species, and other important natural habitats.
- 2-9. Nurdin and Fulbright, (see Literature Cited), undertook a study to determine allelopathic effects of buffelgrass and Kleberg bluestem grass on several wildlife food plants. This

citation was inadvertently left out of the draft recovery plan. Their data results shows that indeed the two grasses inhibit seedling production.

- 2-10. See Recovery Action No. 2.1.3.1. There is no indication that cattle graze the star cactus, although indirect impacts of grazing on associated species may cause deleterious effects on the habitat that the star cactus depends upon.

Comment Letter # 3. Ms. Irene Rico, Director, Planning and Program Development, U.S. Dept. Of Transportation - Federal Highway Administration. May 21, 2002.

- 3-1. Thank you your comment. Timely and appropriate application of pesticides including insecticides and herbicides is important as each may affect the star cactus in various ways. The recovery plan has been modified to reflect that pesticides may pose a threat to the star cactus.

Comment Letter # 4. Mr. Thomas R. Calnan, Coastal Biologist, Texas General Land Office October 30, 2002

- 4-1. Thank you for your review, comment, and support of the star cactus recovery plan.

Comment Letter # 5. Ms. Shelly D. Maher, Research Scientist, Natural Resources Conservation Service - USDA - Kika De La Garza Plant Materials Center, Kingsville, Texas. November 1, 2002.

- 5-1. We appreciate your comments and have incorporated them into the recovery plan. Obtaining baseline DNA studies of known populations would help to confirm whether plants were illegally collected, as well as expand our knowledge of the reproductive aspects and range of the plants.
- 5-2. We have included the information regarding the collection of peyote activities in the discussion of recovery objectives and criteria.

Comment # 6. Ms. Sylvia A. Waggoner, Division Engineer, International Boundary and Water Commission - U.S. & Mexico. November 6, 2002.

- 6-1. Thank you for your comments and the Service appreciates your work in surveying for the star cactus in your maintenance activities, and we look forward to continuing working with the IBWC on recovery measures for the star cactus and other rare species and their habitats.

Comment # 7. Mr. Russell Riley & Ms. Vicki Riley. November 6, 2002.

- 7-1. We appreciate your comments. Although cooperation and collaboration with private landowners is called for in the recovery plan, private landowners are not restricted in respect to land use practices. Landowner involvement is an important aspect of this plan, as the only known United States' population exists on private land, and other populations may be identified through public outreach and survey efforts. As most of the land in Texas is privately owned, we are optimistic that private landowners will be willing to work towards recovery for the star cactus. A number of partnerships may be developed with Federal, state, non-governmental organizations and most importantly the private landowner, that would benefit both the star cactus and private land use practices.

Comment # 8. Dr. Tim Fulbright, Texas A & M University @ Kingsville. November 6, 2002.

- 8-1. We appreciate your comments and support for the recovery plan, and have incorporated information on morphology differences between peyote and the star cactus.

Comment # 9. Mr. Paul Robertson, Science Leader-Wildlife Diversity Program. Texas Parks and Wildlife. November 11, 2002.

- 9-1. Various records of populations by different individuals has led to differing opinions of where the star cactus is still known to occur or whether they were historical populations, new populations or one in the same. Because of this, we cannot make a general statement of numbers of populations that are extant or extirpated until a full scale comprehensive search for all recorded locations has been performed. Within this recovery plan, we have stressed the need to search and/or survey historical, known population sites as well as potential sites based on soil, topography, vegetation, pollinator access, etc. We have included the Counties of Jim Hogg, Webb, and Zapata as potential counties of occurrence.
- 9-2. The Service agrees that reintroduction should take place at areas suitable for long-term protection of the star cactus. As outlined in Recovery Action No. 5: *Reintroduction efforts could be implemented on Federal lands such as those within the Lower Rio Grande Valley National Wildlife Refuge Complex or on state and private lands volunteered for use. Reintroduction programs should be incorporated into applicable agency land management plans. Reintroduction success should be assessed through the development and implementation of a long-term monitoring program.*
- 9-3. The Service agrees that it is not known whether a hot fire associated with the types of plants that now occur with the star cactus relative to historical fire suppression activities would indeed produce a heat element hot enough to affect the cactus. This research is warranted as prescribed in Action No. 2.1.3.3 in the recovery plan.

- 9-4. Monitoring of all known and newly discovered star cactus populations will be an ongoing effort well after downlisting and delisting which will include all aspects of threats, phenology, pollination, etc. in order to understand the life history of the star cactus and fulfill the requirements of the recovery of the plant. Efforts have already been initiated with various stakeholders on the issue of peyote harvesting and star cactus disturbance. It is the Service's desire that a Recovery Team which is in process of formation would include members of state and Federal agencies, Bureau of Indian Affairs, non-government environmental organizations, Mexican partners, and most importantly private landowners. While there may be incidental destruction of star cactus along with harvesting or removal of peyote, the important element is establishing partnerships with Mexico to conserve the habitat.
- 9-5. Based on information gathered since the publication of this draft recovery plan, we have increased the number of populations necessary to initiate downlisting to 10 populations. This is based on records of numbers of populations and the geographical areas where the star cactus is or was known to occur. This number would include populations that are secure self-sustaining populations well protected under a stewardship agreement with the ability to provide long-term monitoring accessibility for researchers. The Service believes that partnerships can be developed with private landowners and the number of ten populations may well increase as recovery actions are ongoing.
- 9-6. We agree that protection and characterization of naturally occurring populations is more important than reintroduction. However, if few additional populations of the cactus are found during extensive surveying, the prospect of reintroducing the star cactus into its historical and geographical range may become necessary to prevent extinction. As stated in the recovery plan, two refuge tracts belonging to the National Wildlife Refuge that have the type of soil and habitat consistent with naturally occurring star cactus habitat are available for potential reintroduction efforts. Other land which may be available for reintroduction efforts, such as state parks, or private land whose owners are willing to enter into agreements to manage and conserve the species would be valuable for long-term protection.
- 9-7. We appreciate your comment and agree that the cactus indeed probably thrives in a variety of habitats with additional associated species. As further partnerships are made with Mexican biologists and other stakeholders as well, we should be able to supplement the information database. It is not yet known what the attributes are that are offered by nurse plants, or whether they do supply an actual assistance in light attenuation, soil stabilization, nutrient supply, etc. This research is warranted as prescribed in Action No. 2.1.3.2. of the recovery plan.
- 9-8. We appreciate your comment, and extend the following information. The formation and colonization of one town, Rio Grande City, located in Starr County and organized in 1847 by Henry Clay Davis, was based on cattle and sheep ranching

which demonstrates the historical vegetational qualities of the area characterized by mid and short grasses, thorny shrubs, mesquite, cacti, and live and post oak.

Handbook of Texas-University of Texas Online: Starr County -
<http://www.tsha.utexas.edu/handbook/online/articles/view/SS/hcs13.html>

Documentation and description of the vegetation in South Texas recorded in the mid to late 1600s, shows that there was not a continuous prairie of grass. Grass may have dominated, although woody plants were present in thickets, upland areas, drainage areas and river bottoms, as well as mesquite being prevalent although less dense as it is now throughout the region. As these ranching communities grew, cattle production increased and with these resulting changes in land use patterns, fire suppression increased causing brush to take hold as well as eliminate ground for grass regrowth.

Texas Parks and Wildlife-South Texas Wildlife Management-South Texas Vegetation
http://www2.tpwd.state.tx.us/southtx_plain/vegetation/index.htm

- 9-9. We appreciate your comment and have modified the Recovery Plan to reflect your comment on effects of land use practices.
- 9-10. We appreciate your comment and have incorporated an action plan for drought effects into the recovery plan.
- 9-11. See response 9-4. We agree that the study of pollinators is an important aspect of recovery for the star cactus and will be ongoing throughout the recovery period.
- 9-12. We appreciate your comment and have incorporated the information into the recovery plan with respect to a recovery team and workshops. Meetings should incorporate research needs as well as research protocol. Monitoring will be ongoing throughout the recovery process. See Response 9-4.
- 9-13. The Service has begun work on a public outreach program to educate collectors including cacti enthusiasts, peyoteros and harvesters, as well as land owners, land managers, consultants, and volunteer groups. Only one population is protected and supports enough plants to produce seed for long-term storage and propagation if reintroduction become necessary. We agree with your comment of upgrading Action No. 7. (Develop a public information and awareness program) to Priority 1 in the Implementation Schedule, to coincide with Action No. 1 (Landowner Information).

It is important that both the one known population is protected, as well as surveying for additional populations. If locating additional natural populations is not successful, it would be advantageous to establish reintroduced populations into areas that are within the geographic and historic range of the cactus. Much of the information on identification of soils and geology, community structure has been collected from various researchers within South Texas. We admit that additional information is necessary before reintroduction efforts would begin. In Mexico as well as the U.S., the star cactus has been found to grow in areas also known to produce naturally occurring peyote and the star cactus is accidentally removed and discarded. Furthermore, it is important to develop

partnerships between Mexico and the United States. Valuable information to exchange would include genetic information as well as furthering our knowledge of pollinators, vegetation, soils, phenology.

- 9-14. We appreciate your comments and have included the agencies (Action No.1) into the Implementation Schedule.
- 9-15. We have increased the funding amount in the soils and geology (Action No. 2.1.1).
- 9-16. The Question and Answer Sheet will be modified for outreach purposes and will include landowner involvement and conservation. We appreciate your comments and are working towards a final fact sheet for public outreach. Zapata County has been included in the Recovery Plan as a historical occurrence. The authority of the species' information has been changed. Star cactus' size description has been modified. Flowering periods have been modified in the Recovery Plan. Contact information has been added to the permitting section for Texas Parks and Wildlife Department. It is our understanding that the population that occurs in an area which occasionally ponds water, is in a creek drainage bed.

Comment # 10. Dr. Martin Terry, Texas A&M University @ College Station. November 15, 2002.

- 10-1. We appreciate your comments and have broadened the scope of genetic research within the recovery plan. As well, we have incorporated the information on stakeholder outreach with respect to peyote harvesting and developing partnerships with the agents involved.

U.S. Fish & Wildlife Service
Corpus Christi Ecological Services Field Office
c/o Corpus Christi State University
6300 Ocean Drive, Box 338
Corpus Christi, Texas 78412
361/994-9005
361/994-8262 Fax

<http://www.fws.gov>

September 2003



Star Cactus

Photograph by Chris Best, FWS, 2003